A RAND NOTE

Observations on the Centurion Shield 90 Exercise

Patrick D. Allen, James P. Kahan,
Thomas F. Lippiatt, Thomas Polsley,
D. Robert Worley

RAND

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Prepared for the
United States Army

RAND

PREFACE

This Note presents interim results of RAND Arroyo Center research on training strategies for the Army, particularly future REFORGER exercises. The emphasis is on the lessons learned from the Centurion Shield 90 (CS 90) exercise, which is the large-scale field exercise associated with the annual REFORGER exercise. The intended primary audience is exercise designers in the U.S. Army, Europe (USAREUR), although any exercise designer might find the Note of interest. RAND's primary focus during CS 90 was on the simulations and the interfaces between the live soldier-in-the-field portions and the computer-simulated portions of the exercise. A companion document (N-3151-A) presents RAND observations on the Caravan Guard 89 (CG 89) exercise, with recommendations for CS 90. Our findings from the CG 89, CS 90, and other exercises will be incorporated into a comprehensive report on future REFORGERs, as part of RAND's project on "Unit Training Strategies."

This research was conducted in the Arroyo Center's Manpower, Training, and Performance program and was carried out through the Arroyo Center's USAREUR office in Heidelberg, Germany. Mr. Polsley, one of the authors of this Note, is an employee of the U.S. Army Training and Doctrine Command (TRADOC); he was assigned to the Arroyo Center's USAREUR office in 1989-1990.

The Arroyo Center

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Lynn E. Davis is Vice President for the Army Research Division and Director of the Arroyo Center. Those interested in further information about the Arroyo Center should contact her office directly:

Lynn E. Davis
RAND
1700 Main Street
P.O. Box 2138
Santa Monica, CA 90407-2138

SUMMARY

PURPOSE AND BACKGROUND

The necessity of continued military exercises in Central Europe has been questioned, especially during this time of reduced East-West tensions. Large-scale field exercises are economically and politically costly. One of the more obvious negative aspects of such exercises is maneuver damage—the damage to civilian crops and property caused by units maneuvering over private and public property during training.

The employment of more simulations and less actual combat equipment is one way to reduce the costs of maneuver damage, as well as the overall operational costs, of an exercise. In addition, simulations tend to exercise certain functional areas not usually exercised by traditional training methods, such as many functions of the intelligence staffs.

In January 1990, the United States Army, Europe (USAREUR) mounted one of its major periodic exercises, Return of Forces to Germany (REFORGER). As part of the 1990 REFORGER, Army personnel engaged in an innovative field training exercise, Centurion Shield 90 (CS 90), conducted from 15 through 26 January. CS 90 was the second in a series of experiments carried out by USAREUR, combining live and simulated units in a single exercise.[1] A small number of units, particularly light infantry, were deployed in Field Training Exercise (FTX) mode, while the bulk of the two opposing corps units were deployed in Command Field Exercise (CFX) mode. In the latter mode, wheeled vehicles are deployed to stand for their respective companies and batteries. Simulated forces were played in three separate combat simulations: the ground combat model (GRWSIM) and air combat model (AWSIM) of the Warrior Preparation Center (WPC) and the Corps Battle Simulation (CBS) of the U.S. Army.

In the FTX mode, all or most of the equipment and personnel in a unit are placed in the field and often oppose other units deployed in the FTX mode. The FTX mode of training is the most expensive mode because of the expenditure of consumables (fuel, food, and spare parts) and in terms of maneuver damage. At the same time, the FTX mode has tended to be the most realistic mode of training by placing the largest number of personnel and equipment under field conditions, with all of the obstacles and pitfalls of maneuvering in the field.

[1]The first exercise in the series was Caravan Guard 89 (CG 89), run in September 1989; CS 90 was more extensive and more complicated than CG 89. For details, see P. Allen et al., *Observations of the Caravan Guard 89 Exercise*, RAND, N-3151-A, forthcoming.

In the CFX mode, only a portion of the personnel and equipment is placed in the field. Fewer personnel and equipment in the field mean reduced costs in both consumables and maneuver damage. Sometimes, substitute equipment (such as wheeled instead of tracked vehicles) are used to further reduce the cost of consumables and maneuver damage. However, the CFX mode of training tends to contain more artificialities than does an FTX. For example, two CFX command vehicles each representing an opposing company may pass each other in the field without contact, while actual companies in the field would detect and engage each other.

Simulated units tend to have either no equipment and personnel in the field or only the equipment and personnel of a brigade or battalion headquarters. The costs of exercises that employ simulation are quite small in terms of consumables and maneuver damage, although the simulations entail their own costs. For example, the computer hardware and software must be obtained. Even if these items are considered "sunk costs," each exercise requires increased personnel to operate the simulation equipment as well as increased communications costs to connect the simulation to the participating headquarters. Finally, the validity or realism of the simulations in the support of the training objectives continues to be strongly debated.

Additional artificialities occur when multiple training modes are used in a single exercise. For example, it is difficult to assess combat results between an FTX unit with all of its equipment and personnel against a CFX unit with a fraction of the equipment and personnel. As another example, it is even more difficult to assess combat results between units in the FTX mode and units in the simulation mode. How does the "live" side fight a simulated opponent who presents no signature in the field?

This Note presents observations and recommendations on issues emerging from Arroyo Center staff observations of CS 90. Our focus was on the simulation interfaces, including simulations linked with each other and with units on the ground. The document is intended to provide a record of observations and comments on CS 90 for use by the USAREUR staff and other staffs that are planning large-scale field exercises. An earlier draft of the document contributed to the preparation of REFORGER 91 and the planning of REFORGERs 92 through 95. Ongoing RAND research will examine the lessons learned from this exercise to derive implications for a variety of future Army exercises.

FEATURES OF CENTURION SHIELD 90

The scenario for CS 90 represented a conflict between a country called "Northland" (actually on the east with capital Regensburg) against a country called "Southland" (actually on the west with capital Karlsruhe). The border between the countries ran in a north-south line between the two capitals, within the real-world Federal Republic of Germany. REFORGER exercises traditionally pit two corps in the FTX mode against each other in the field. In CS 90, two simulated corps were added to the force mix for each side. Each country's army was headed by an Army Group and fought with two corps on line, one to the north and one to the south. The two simulated corps fought in the north, one on each opposing side. In the south, the forces were real: the U.S. V Corps fought for Northland while the U.S. VII Corps fought for Southland.

The geographical arrangement of the live and simulated training modes is presented in Fig. S.1. The live CFX/FTX "box" was in the southern portion of the full exercise box. The CBS box covered a brigade sector to the north of the CFX box. The GRWSIM model covered a corps sector to the north of the CBS box, as well as the deep battle areas of the the V and VII Corps. To present a Red threat to the corps deep battle staffs and flank liaison officers, two GRWSIM games operated simultaneously over the same geographical area. For example, the simulated corps (LXXI) north of U.S. VII Corps fought against a Red opponent (the 59th Tank Army). Meanwhile, the simulated corps (LIX) north of U.S. V Corps fought against a Red opponent (the 71st Tank Army).

To further complicate the situation, two additional simulated corps were supposed to replace the "live" corps on-line during the transition weekend. Traditionally, the transition weekend is used to shift one live corps from the offense to the defense, while the opposing corps does the opposite. The transition weekend is usually performed in the administrative mode so that no combat occurs over the weekend. However, since simulations were being employed, it was decided to have the simulated forces continue to fight through the transition weekend. A similar situation with simulated forces fighting through the transition weekend was performed during CG 89.

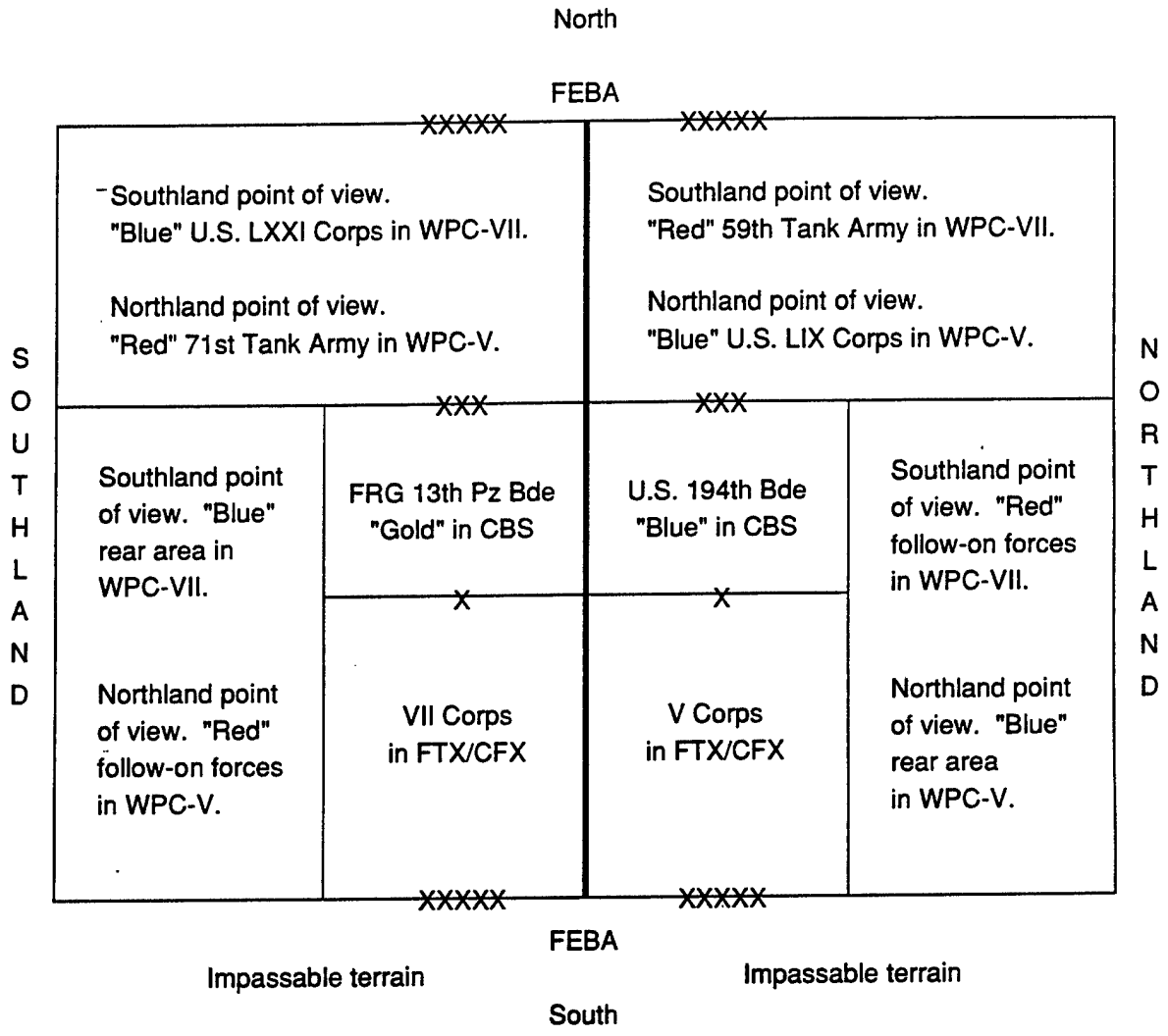

Fig. S.1—The CS 90 battlefield (not to scale)

EXERCISE OBSERVATIONS

Our observations of the exercise follow, beginning with issues related to exercise design, preparation, and control and proceeding through the principal military functional areas identified by the Exercise Division, USAREUR, as important in CS 90. When an issue addresses several functional areas, it is listed under the most dominant one. We examined the following functional areas:

- Unit resolution (and passing information back and forth)
- C2
- Air
- Air defense
- Army aviation
- JSEAD
- EW (including SIGINT, ELINT, and countermeasures)
- Threat play
- Intelligence
- Deception
- Corps picture
- Close operations
- Deep operations
- Rear operations
- Fire support (non-air)
- Combined arms
- Engineers
- Signal
- CSS
- Airborne/air assault

The issues are presented in the format requested by the project Action Officer, the Chief of the Exercise Division, USAREUR: An issue is presented, discussed with an example or two, and then a recommendation is made. Thus, for each issue, both observations from CS 90 and recommendations for future exercises are given.

CS 90 manifested improvements in many of the problems identified in CG 89. This was significant not only because of the resulting improved training environment, but also because the recommended improvements were implemented within a very short period of time. As anticipated, new issues were raised by CS 90. Table S.1 lists the 47 issues presented in the paper. (Except where noted, each issue is important to performing large-scale multi-echelon, multi-mode training exercises.) Although all of the issues are important, the most significant can be summarized into five categories:

Table S.1
ISSUES ADDRESSED IN THIS NOTE

Design, Preparation, and Control

1.* Unscheduled simulation downtime was significantly reduced during this exercise.
2. Scheduled simulation downtime sometimes created problems in exercise support
3. The information exchange interface between simulations was not well developed.
4. No one monitored the simulated borders or the geographical interfaces between simulations.
5. The two overlapping GRWSIM/AWSIM games confused both players and controllers.
6. The continuous simulated battle over the transition weekend took a great deal of effort and was unrealistic.
7. Actual unit staffs performed better than ad hoc unit staffs as training support augmentees.
8. Simulated headquarters were inadequately staffed.
9. There was insufficient preparation time for augmentees.
10. For this corps-level exercise, the adjacent simulated corps did not capture the attention of the training audience.
11. The force ratios were poor for attack scenarios.
12. The portrayal of the threat to the deep and rear operations cells was hindered by unforeseen scenario limitations.
13. The scenario was unclear about whether the reserve divisions were national assets or NATO assets.

Issues by Functional Area

14. The accuracy of the location of friendly and enemy units differed among training modes.
15. There was confusion early in the exercise because the simulated command and control structure was not well understood.
16.* The distinction between AWSIM air and CBS air was much better defined and implemented than previously.
17. The live and simulated air operations were not well integrated.
18. The flight of simulated aircraft was as restricted by weather as that of actual aircraft.
19. Air defense assets were well coordinated among simulations.
20. Simulated air support operations centers were not informed of damage against penetrating aircraft.
21. Live corps air defense assets were not involved in the air conflict.
22.* Simulated Army aviation in GRWSIM was not realistic.
23. Little joint suppression of enemy air defense was played in the simulations, with very limited results.
24. Little electronic warfare was played in this exercise.
25. The balance between Red and Blue logistics and intelligence capabilities was appropriate.
26.* In GRWSIM, Red units were not allowed the same benefits of the defend posture as Blue units.

Table S.1 (Continued)

27. Some Red and Blue unit sizes in the WPC simulations were inappropriate for the scenarios in CS 90.
28. The different update times and resolution in each training mode created difficulties in the intelligence functional area.
29. Unadjusted intelligence collection model output is too detailed for exercises of the magnitude of CS 90.
30. The management of "magic moves" needs to be tightened.
31. Intelligence representation does not work well in CFX mode.
32.* Deception operations were planned and executed by both V and VII Corps.
33. The corps picture was not seamless between simulations and live play.
34. Close operations in the simulations need additional calibration.
35. Due to scenario limitations, the deep operations cell was not sufficiently stressed.
36. Although attempted, there was little rear threat to either live or simulated corps in CS 90.
37. The Fire Support Cells (FSCs) received good training.
38. The counterbattery representation needs to be improved across all training modes.
39. Artillery should be constrained by ammunition supply, but this does not occur in the CFX/FTX, nor often in the simulations.
40. Light infantry is not well trained when employed in good tank country.
41. The benefits of deep reconnaissance and targeting are not well measured in current CFX/FTX exercises.
42. The major representation of minefields on hex-based terrain creates major artificialities in the simulations.
43. A CFX appears to be inadequate for training the basic signal functional area tasks.
44. The live corps combat service support (CSS) activities focused on maintaining the exercise rather than supporting the training of the CSS activities.
45. CSS constraints need to be able to restrict the activities of combat and combat support units in the exercise.
46. Consumption rates in the models may exceed FM 101-10-1 and FM 101-10-2 planning factors.
47.* The representation of air assault operations was realistic.

* Denotes issue specific to CS 90 exercise. All other issues apply to large-scale multi-echelon multi-mode training exercises.

- **Exercise Design:** The mixed-mode exercise design in CS 90 did not provide a completely "seamless battlefield." The two overlapping GRWSIM games led to some confusion among players and controllers. The separate brigades within the CBS "box" operated relatively independently and were not well integrated into the corps battle. The simulated and live parts of the battle were often handled differently by the players if they anticipated confusion.
- **Exercise Manning:** Simulated headquarters need to be sufficiently manned to provide realistic human contact with exercised staffs. Actual unit staffs perform better in exercises than ad hoc staffs assembled for an exercise. Preparation and training of support augmentees need to be improved.
- **Scenario-Related Issues:** The employment of an adjacent simulated corps in GRWSIM did not demand sufficient attention from the training audience. If simulated units are employed on the flanks, they should be made more salient to the activities of the training audience. In addition, the force ratios employed in the scenarios should more closely match Blue and Red doctrine. For example, attacks are not usually launched at a 1:1 force ratio. The continuous transition weekend was awkward and not realistic. If the continuous weekend transition is employed, it should be in conjunction with a smaller CFX/FTX force. If the exercise is going to function 24-hours-a-day, the simulation support should be available 24-hours-a-day.
- **Threat Representation:** The representation of the threat versus Blue forces needs to be more balanced. Red forces in GRWSIM need to be allowed to receive the same benefits of the defense posture as the Blue forces. In the same model, Blue attack helicopter capabilities need to be much more realistic. In addition, the unit resolution should be appropriate for the scenarios being represented. The threat to the deep and rear operations cells needs to be continuous over time and synchronized with Red close operations.
- **Simulation Calibration:** The close operations and supply consumption representations in each simulation need to be compared with each other and with the standard U.S. Army planning factors in FM 101-10-1 and FM 101-10-2. This is especially true of combat attrition rates and artillery consumption rates. The differences between these sources of data need to be better understood.

When simulations are employed in support of field exercises, the tradeoffs between changes in training benefit and training costs are still not well understood. Preliminary

results indicate that the quality of training in several functional areas is probably improved through the use of simulations, but this is very qualitative and difficult to measure. There are reduced operational and maneuver damage costs but increased costs of simulation support, especially in communications costs to run large simulations distributed to remote sites in the field. Although cost data are much more quantitative, they are also less available due to the number of financial sources that are involved in funding a single large-scale field exercise. More detailed costs estimates will be provided in the final report of the project. In this document, only rough cost estimates (such as high, medium, or low) are included when referring to the various options that were employed or have been recommended herein.

This document does not address the issue of whether the use of mixed modes of training in a single exercise is desirable. There are a number of potential benefits as well as a number of tangible artificialities that occur in exercises that employ more than one training mode. Whether the benefits of mixed-mode training exercises outweigh the costs and complications is a subject reserved for the project's final report. In a similar manner, the authors address neither the desirability nor the costs involved in employing more than one ground combat simulation in a single exercise. Overall, this document is intended to provide detailed supporting material for the project, deferring predictions about the future of simulation support of large-scale field exercises until the final report.

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CONTENTS

FIGURES

GLOSSARY OF ACRONYMS

ACC	Air Control Center (for exercises)
AD	Air Defense
ADA	Air Defense Artillery
AEB	Air Exploitation Battalion
AI	Air Interdiction
ASOC	Air Support Operations Center
ATOC	Air Tactical Operations Center
AWSIM	Air War Simulation (a combat model), housed at WPC
BAI	Battlefield Air Interdiction
BCTP	Battle Command Training Program
CAS	Close Air Support
CB	Counter-Battery (fires against enemy artillery)
CBS	Corps Battle Simulation (a combat model)
CENTAG	(NATO's) Central Army Group
CEWI	Combat Electronic Warfare and Intelligence
CFX	Command Field Exercise (only command vehicles used)
CG 89	1989 Caravan Guard exercise
CINCUSAREUR	Commander-in-Chief, USAREUR
Class I	Supplies—rations
Class II	Supplies—individual equipment
Class III	Supplies—petroleum, oil, and lubricants
Class IV	Supplies—construction materials
Class V	Supplies—ammunition
Class VI	Supplies—personal items
Class VII	Supplies—major end-items
Class VIII	Supplies—medical items
Class IX	Supplies—repair parts
CMTC	Combat Maneuver Training Center, Hohenfels, Germany
COMCENTAG	Commander, CENTAG
CONUS	Contiguous United States (not Hawaii and Alaska)
COSCOM	Corps Support Command
CPX	Command Post Exercise (no maneuver units fielded)
CS 90	1990 Centurion Shield exercise
CSR	Controlled Supply Rate
CSS	Combat Service Support
C2	Command-and-Control
EAC	Echelons Above Corps
ECC	Exercise Control Center
EIFEL	NATO Air Forces communication system (German acronym)
ELINT	Electronic Intelligence
ENDEX	Time that an exercise ends
EW	Electronic Warfare
FEBA	Forward Edge of the Battle Area
FFRDC	Federally Funded Research and Development Center
FLOT	Forward Line of Own Troops
FSC	Fire Support Cell
FSE	Fire Support Element
FSO	Fire Support Officer

FTX	Field Training Exercise (all or most vehicles used)
G1	General Staff section for personnel (and its head)
G2	General Staff section for intelligence (and its head)
G3	General Staff section for operations (and its head)
G4	General Staff section for logistics (and its head)
G5	General Staff section for civilian affairs (and its head)
GRWSIM	Ground War Simulation (a combat model), housed at WPC
hex	hexagon—the basic geographical unit for many models
HIMAD	High and medium altitude air defense
ICM	Intelligence Collection Model
JESS	Joint Exercise Support System (now called CBS)
JSEAD	Joint Suppression of Enemy Air Defenses
JWARS	Joint Warfighting Simulation: AWSIM plus GRWSIM
JWC	Joint Warfare Center, Hurlbert Field, Florida
km	kilometer
LNO	Liaison Officer
LRSU	Long Range Surveillance Unit
MILES	Military Exercise System
MLRS	Multiple Launch Rocket System
MOE	Measure of Effectiveness
MOS	Military Occupational Specialty
NA	Not Applicable
NAI	Named Area of Interest
NATO	North Atlantic Treaty Organization
NTC	National Training Center, Fort Irwin, California
OCA	Offensive Counter Air
POC	Point of Contact (a person)
POL	Petroleum, Oil, and Lubricants
POMCUS	Prepositioned Overseas Materiel Configured in Unit Sets
REFORGER	Return of Forces to Germany exercise
RIPL	Reconnaissance Interdiction Planning Line
ROE	Rules of Engagement
RUF	Ruppersweiler Underground Facility
SHORAD	Short Range Air Defense
SIGINT	Signals Intelligence
SOF	Special Operations Forces
STARTEX	Time that an exercise begins
SYNADEX	Synthetic Air Defense Exercise
TACFIRE	Tactical Fire direction system
TAI	Target Area of Interest
TBD	To Be Determined
TOC	Tactical Operations Center
TRS	Tactical Reconnaissance System
UCC	Umpire Control Center of an exercise
USAREUR	United States Army, Europe
UTM	Universal Transverse Mercator (map coordinates)
WPC	Warrior Preparation Center, Einsiedlerhof, Germany

I. OVERVIEW

INTRODUCTION

For over twenty years, the United States Army, Europe (USAREUR) has staged on a nearly annual basis an exercise called Return of Forces to Germany (REFORGER). This exercise has placed in the field U.S. Army divisions and brigades from the contiguous United States (CONUS) and forces already in Germany.

Changing circumstances, including increasing resistance to field exercises in Germany, political pressure in the United States to reduce military expenditures, and—not least—the tumultuous changes in the European political picture, have called into question the utility of live field exercises such as REFORGER in Europe.[1] USAREUR, in an attempt to maintain REFORGER with lower costs and a lower "profile," conducted a modified REFORGER in January 1990. The most significant part of the modification was the substitution of simulated units and units reduced in size for most of the forces employed. Only a small number of units, particularly light infantry, were deployed from CONUS in Field Training Exercise (FTX) mode to participate in the Centurion Shield 1990 (CS 90) tactical exercise. The bulk of forces were represented either in Command Field Exercise (CFX) mode or by computer simulations in Command Post Exercise (CPX) mode.[2] These modifications were intended to:

- Reduce maneuver damage to private and public civilian property during training,
- Reduce the overall operating costs of the exercise, and
- Enhance the training value of CS 90 by exercising certain functional areas, such as intelligence, more than is done in field exercises.

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[1] Technically, REFORGER is not a single exercise but a combination of U.S. Army, U.S. Air Force, and allied exercises all taking place simultaneously. These separately named exercises involve the deployment of forces from CONUS to Europe as well as battlefield events once in Europe. CS 90, which took place from 15 through 26 January 1990, is the name of the battlefield exercise portion of 1990 REFORGER.

[2] In FTX mode, units deploy to the field just as they would in battle, but they do not fire live ammunition. Umpires judge the outcomes of engagements and indirect fires. In CFX mode, companies and batteries are represented by one or two command vehicles that travel the battlefield terrain. In CPX mode, headquarters (typically brigade and higher) are in the field, but all other units are artificially represented. Increasingly (and particularly in CS 90), computerized models replace umpires in assessing the outcomes of CPX battles.

An Experimental Exercise

Although CS 90 was primarily a training exercise, it was also an experiment to test the feasibility of a mixture of training modes employing both live and simulated units. The training modes used in CS 90 were: (1) the units in the field in FTX mode, (2) the units in the field in CFX mode, (3) the simulated units represented in Corps Battle Simulation (CBS), and (4) the simulated units represented in the Ground War Simulation (GRWSIM) and Air War Simulation (AWSIM). The personnel selected as the focus of the training are the training audience. A different training audience is usually associated with each training mode.

The FTX mode is the traditional training mode for previous REFORGER exercises. Since live forces are deployed from CONUS to Europe as part of the REFORGER exercise, it was considered cost effective to train the deployed units on the type of terrain in which they may need to fight. In the FTX mode, the training audience consists of whole units, including all personnel and equipment deployed to Europe or with equipment drawn from POMCUS[3] sites in Europe. Full-strength units are employed in this mode, so the cost of every unit participating in the FTX mode is high in terms of consumables such as fuel, spare parts, and food. In addition, the cost of maneuver damage tends to increase the larger the force in the field. However, the training benefits obtained by overcoming the numerous obstacles that occur when operating large numbers of troops in the field are also considered high.

During CS 90, the original plans were to have some of the maneuver units in the FTX mode and some in the CFX mode, as was done in the Caravan Guard 89 exercise a few months earlier. Because of budget limitations, the only maneuver units in the FTX mode were light infantry units. The remainder of the maneuver forces were trained in the CFX training mode.

The CFX training mode is a less costly option used to train only the command elements as the training audience. Instead of fielding the whole unit, only the command vehicles of companies or platoons are placed in the field. Since fewer personnel and equipment are operating in the field, the cost of consumables is proportionally reduced, as well as the likely degree of maneuver damage. Maneuver damage can be reduced even further by substituting wheeled vehicles for tracked command vehicles. Although the costs of the CPX mode are less, the training benefit applies to a smaller audience. Only the commanders receive training benefit in the CFX mode, since their subordinates are not actually in the field. Furthermore, some of the artificialities of the CFX mode result in less

[3]Prepositioned Overseas Materiel Configured in Unit Sets.

training of certain functional areas. For example, it is more difficult for intelligence collection assets to detect a single vehicle representing a whole company than it is to detect the whole company if it were actually fielded.

The cost of consumables and maneuver damage is even smaller when simulated units are used. Like the CFX mode, only the command elements are included in the training audience, which consists of commanders and staffs from battalions and higher echelons. These command elements may be in garrison or in the field, depending upon the simulation being employed and the training objectives. There are additional costs associated with obtaining, maintaining, and operating the computer hardware and software used to support an exercise, as well as the communications costs associated with connecting the various sites to the central computing location. However, the operating costs of an exercise that employs simulations still tend to be less than the operating costs of exercises that use the FTX or CFX training modes. Unfortunately, in every exercise there are also a number of artificialities associated with simulations that cause many participants to question the realism and validity of the simulations. CS 90 was the first REFORGER exercise to include simulation as one of the primary training modes.

A major element of the experiment concerned the choice of computer simulation. The two major candidates were the Corps Battle Simulation (CBS)[4] and the Warrior Preparation Center (WPC) system of GRWSIM (a ground warfare combat model) and AWSIM (an air warfare combat model). Each of the two candidates presented difficulties. CBS, designed for division-level and corps-level training, was deemed by some as inadequate for the deep and rear operations required for CS 90. The WPC system, which was often used for Echelons Above Corps (EAC) training, was considered by others as not having the resolution necessary for representing the CFX forces. In an attempt to have the best of both worlds, USAREUR decided to employ both candidates, using each where it was best suited.

Each training mode has a number of advantages and disadvantages when considered individually. In addition, there are a number of artificialities and potential benefits that occur when combinations of training modes are used together in the same exercise. For example, one may reduce operating and maneuver damage costs by employing some units in the FTX mode and some units in the CFX mode. The problem is that it is difficult to assess the results of combat between a unit in the FTX mode and a unit in the CFX mode. It is even more difficult to assess the results of combat between a unit in the FTX mode and a simulated unit that is not represented on the ground at all. When using multiple

[4]Until October 1989, CBS was called the Joint Exercise Support System (JESS).

simulations to support an exercise, selected items of information need to be passed between the simulations in a timely manner in order to coordinate the actions in each simulation. The interface software required to pass the necessary information between simulations is often difficult to develop and fraught with unanticipated errors. This Note does not address the issue of whether one should use multiple simulations or a single simulation to support a single exercise.

The Nature of This RAND Note

RAND was asked by USAREUR to assist in evaluating the mixed-mode exercise experiment. We were asked to focus on the interfaces among the three systems, and in particular to identify issues of specific concern for future Army exercises and for future REFORGERs.[5] This Note documents RAND's observations of CS 90; a companion Note[6] documents our observations of the 1989 Caravan Guard (CG 89) V Corps exercise that was the pilot test of the mixed-mode exercise design. At the request of the Exercise Director, USAREUR, we present our observations in a specified format, on an issue-by-issue basis. First, we state the issue. Second, we discuss the issue, including an example or two to clarify the issue statement. Finally, we recommend action with respect to the issue. Section II of this Note presents issues related to exercise design, preparation, and control of CS 90, whereas Section III presents issues regarding the principal military functional areas identified during the conduct of the exercise. Section IV briefly summarizes the issues.[7]

Two appendices provide detailed specifications of important aspects of the CS 90 experiment. Appendix A outlines the data collection plan used by RAND staff for observing CS 90. Appendix B gives the Rules of Engagement provided by the USAREUR Exercise Directorate to adjudicate interactions between simulations and live exercise modes in the exceptional instances when such interactions occurred.[8]

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[5]An earlier draft of this Note contributed to the preparation of REFORGER 91 and the planning of REFORGERs 92 through 95.

[6]P. Allen, T. Lippiatt, L. Pleger, and T. Polsley, *Observations of the Caravan Guard 89 Exercise*, RAND, N-3151-A, forthcoming.

[7]This Note is limited to observations of the CS 90 exercise. A separate work, looking across the experience of several exercises, will address the larger question of the nature of future REFORGER and similar exercises.

[8]The Rules of Engagement were written by Major Thomas Hill of the USAREUR Exercise Directorate. They are included here with the permission of USAREUR. The discussion about which rules of engagement worked well and which did not was written by the lead author, based upon discussions with Major Hill.

A BRIEF DESCRIPTION OF THE BATTLE AREA

Before proceeding to our examination of issues emerging from CS 90, we briefly describe the battle it portrayed. CS 90 was played as major operation between the forces of two countries called "Northland" (capital Regensburg) and "Southland" (capital Karlsruhe). Despite their names, the two countries were depicted in an east/west relationship with each other, with their common border a north-south line roughly between the two capitals, within the real-world Federal Republic of Germany. Each country's army was headed by an Army Group (represented for both countries by CENTAG) and fought with two corps on line, one to the north and one to the south. To the north, the opposing corps were simulated, while to the south, the forces were real: the U.S. V Corps fought for Northland while the U.S. VII Corps fought for Southland.

The geographical arrangement of the live and simulated training modes is presented in Fig. 1. The live CFX/FTX box, where U.S. V Corps and U.S. VII Corps units engaged each other, was in the southern portion of the full exercise box. (Note that in this scenario there was no southern flank, which was assumed to be impassible mountains.) In the center of the exercise box, the U.S. 194th Brigade (under V Corps control) engaged the German 13th Panzer Brigade (under VII Corps control). For CBS purposes (the computer model will not permit a Blue vs. Blue battle), the 194th was labelled Blue and the 13th was labelled Gold. The northern portion of the exercise box and the far eastern and far western edges of the box were both portrayed by the AWSIM and GRWSIM simulations of the WPC.

To present a Red threat to the corps deep battle staffs and flank liaison officers, two GRWSIM games operated simultaneously over the same geographical area. For example, the simulated Blue LXXI Corps north of U.S. VII Corps fought against a Red opponent called the 59th Tank Army. Meanwhile, the simulated Blue LIX Corps north of U.S. V Corps fought against a Red opponent called the 71st Tank Army. In a similar manner, the V Corps deep battle cell was tracking Red divisions to the rear of VII Corps, and the VII Corps deep battle cell was tracking Red divisions to the rear of V Corps. The WPC-V and WPC-VII games were entirely independent of each other. Thus, each of the U.S. *simulated* corps fought the battle from the perspective of a Blue unit fighting a Red enemy.[9] The CBS and live forces were played from a common perspective, where Blue and Gold forces faced each other in the FTX/CFX box. The exercise Rules of Engagement (see App. B) went into considerable detail about which model would prevail when forces within one box interacted with forces within another box.

[9]The FTX and CFX forces in the field carried Gold identifiers for VII Corps and Blue identifiers for V Corps to avoid total confusion.

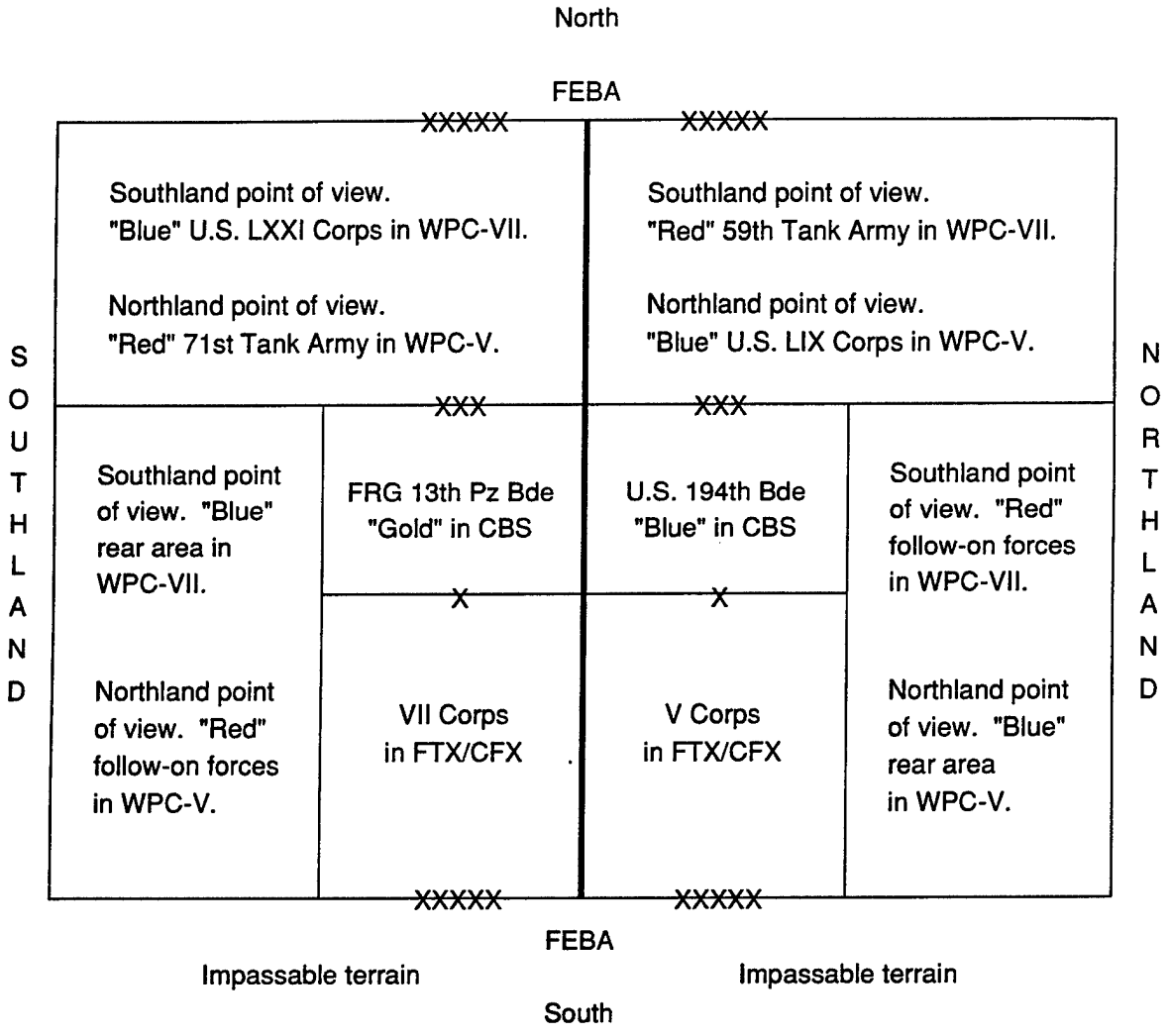

Fig. 1—The CS 90 battlefield (not to scale)

In CS 90, Northland attacked Southland for the first week, whereas Southland counterattacked during the second week. During the weekend, the CFX/FTX units in the field recuperated from the battle and relocated for the following week's battle in an administrative mode. While the lower echelons rested, the V Corps and VII Corps staffs continued the exercise; each corps was required to role-play the command post of the simulated corps that replaced it. The "story" behind this maneuver is that a simulated corps had performed a passage of lines on Friday night, and the live corps performed another passage of lines on Sunday night. That is, for 48 hours, a portion of the V Corps staff commanded the simulated units of the CLIX Corps, while a portion of the VII Corps staff commanded the simulated units of the CLXXI Corps staff. The weekend battle was accomplished by expanding the WPC simulation box on the weekend to cover the entire exercise box, thereby attempting to present a continuous picture to the corps staffs. At the start of the second week, the WPC simulation box was shrunk to its original size, and the CFX/FTX units were re-inserted into play.

II. EXERCISE DESIGN, PREPARATION, AND CONTROL

In this section, we address issues relating to exercise design and control. All of the issues discussed are in the context of the short planning horizon of CS 90. The CG 89 exercise, which was a pilot for the mixed-mode experiment of CS 90, ended on 20 September 1989, leaving only three months to implement design changes for an exercise that was planned for over a year. In addition, the REFORGER 90 elements were being deployed to Europe in December, with equipment packing, manifests, and personnel lists prepared ahead of time. Finally, late in the planning period, the decision was made to replace most of the REFORGER tracked vehicles with wheeled vehicles. This caused a significant realignment of forces, personnel, and their equipment for CS 90.

In spite of these major hurdles, a number of significant improvements were implemented in the design of the CS 90 exercise. Many problems encountered during CG 89[1] were solved in CS 90. For example:

- Computer and communication downtime were significantly reduced.
- Air and air defense coordination between the two simulations was much better.
- There was more participation by Air Force personnel.
- Blue and Red were more balanced in intelligence and logistics representation.

As might be expected, several new design, preparation, and control issues arose during CS 90, which we address here. Where the issue identifies a problem, we make recommendations in the form of alternatives to an implementation in CS 90. We discuss in broad terms the estimated benefits and costs of each option so that better informed decisions can be made for the design of the next major field exercise in Europe. Unless noted by an asterisk after the issue number, each issue applies to any future large-scale, multi-echelon, multi-mode training exercise.

Issue 1 (*): Unscheduled simulation downtime was significantly reduced during this exercise.

Discussion: Because of the experience in earlier exercises, there was concern that the simulations system could go down for long periods of time. This concern resulted in the exercise having redundant computer systems and communications links. Virtually no single system was necessary to the entire exercise. As a result, there were few unscheduled interruptions of the simulation support from problems in communications links, computer

[1] See Allen et al., N-3151-A.

hardware, or computer software. For an example of one of these interruptions, an air conditioning failure at the Exercise Control Center (ECC) caused the CBS game to be transferred to the backup computer, delaying the CBS portion 90 minutes one morning. What interruptions that occurred caused little delay in the support of the exercise and were virtually unnoticed by the players.

Recommendation: A major reason for the success of the linkage was the redundancy of systems. Lack of system failure in one exercise is no guarantee that it will not fail in a future exercise. Therefore, care should be taken to ensure that the redundancy in communications and computer support is maintained in future exercises. A backup computer is an essential requirement for exercises that employ simulations. In many cases, the backup computer may be borrowed from another military facility, or even directly from the vendor. The cost of borrowing a backup computer is often less than purchasing one that may be idle except during exercises. Unfortunately, ensuring backup communications systems may cost as much as providing the primary communications systems. However, the added communications costs tend to be smaller than the opportunity cost of stopping or delaying the whole exercise.

Issue 2: Scheduled simulation downtime sometimes created problems in exercise support.

Discussion: Although unscheduled downtime was not a problem, the *scheduled* downtime did create some difficulties. Because of staffing problems and the need to maintain systems, some of the computer systems were down, often for long periods of time. For example, in one instance the overnight planning of an early morning counterattack could not be implemented within the computer systems because the computers were down from 2200 to 0600 hours, as scheduled. As a result, the command post and field staffs—who functioned on a 24-hour-a-day basis—did not receive continuous computer support. For another example, some of the players, knowing the computers to be down, turned off their printers, resulting in the communications links from CBS to the remote sites becoming backlogged overnight. The backlog, consisting largely of obsolete information, dumped to the printer in the morning, preventing the printing of more timely information waiting in the queue.

Recommendation: If the exercise objectives require 24-hour operations, then 24-hour-a-day simulation operations should be provided. The costs of maintaining a simulation 24-hours-a-day are great, since at least two shifts of personnel are required. Nevertheless, as the Battle Command Training Program (BCTP) has shown, the simulations can be maintained on a 24-hour-a-day basis, with a resulting gain in realism and stress for the units

being trained.[2] The technology is available to ensure that any exercise conducted on a 24-hour-a-day basis can have 24-hour-a-day computer simulation support. Once this is standard operating procedure, player- and controller-induced problems with regard to gaming downtime will largely disappear.

Issue 3: The information exchange interface between simulations was not well developed.

Discussion: If a WPC unit engaged a CBS unit in direct or indirect fire, it was involved in combat for 24 hours. At the end of 24 hours, the WPC unit was released at zero percent strength (destroyed), whereas the CBS unit received no losses. This occurred regardless of the sizes and types of units involved. For example, a WPC Red antitank battalion engaged a CBS Blue reconnaissance company. The Red unit was completely destroyed, whereas the CBS unit received no damage. The problem appeared to be caused by the fact that the unit percent strength data passed between GRWSIM and CBS were not handled properly by the interface in operation for this exercise. (Both the WPC and the CBS system managers agree that the other three data items passed between the systems—namely the unit's name, grid coordinate, and mission—were passed correctly in this interface.)

Recommendation: There are two recommendations for this problem.[3] First, continue interface development between the CBS and GRWSIM ground models to fix the bug. Second, to prevent such bugs from disturbing future games, have at all times one person (a "system deconflicter") on each shift in charge of the simulation interface monitoring and control. Then, when such bugs surface, that person has both the knowledge and authority to do what is necessary to minimize the damage to the exercise caused by the bug. The cost of this option will depend upon the availability of personnel with the appropriate skills and knowledge of the interfaces. A less expensive option would be to have a person with some operational knowledge observe the interactions across the interface. When a problem arises with the interface, the observer brings it to the attention of personnel who know how to fix it.

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[2] J. P. Kahan, D. R. Worley, S. M. Holroyd, L. C. Pleger, and C. Stasz, *Implementing the Battle Command Training Program*, RAND, R-3816-A, August 1989.

[3] We assume here that exercises involving interfaces between different combat simulations in the same exercise will continue. Reasons for or against using multiple simulations are not addressed in this Note.

Issue 4: No one monitored simulated borders or the geographical interfaces between simulations.

Discussion: The intent of the game designers was not to preclude units "belonging" to different simulations from interacting with each other, but to preclude them from interacting in an unrealistic manner. This intent was not realized. For example, it was assumed that the country north of the simulation box was neutral. However, there were many Blue air and ground violations of this international border. These violations, although unintentional, were caused by uncertainties in the exact locations of the simulated boundaries on Blue and Red situation maps. Similarly, in the southern portion of the GRWSIM box, the boundary with the CBS box was not well defined. Blue GRWSIM units would enter the CBS box and attack Red GRWSIM units. A third example demonstrates even worse effects: if a Blue GRWSIM unit was collocated with a Blue CBS unit, the Blue GRWSIM unit was virtually invulnerable to any attack by Red GRWSIM units (see preceding issue).

Recommendation: The system deconflicter we recommended in the preceding issue should be in charge of monitoring and controlling the simulation borders to preclude intentional or unintentional violations of the exercise assumptions. Better, the monitoring of the simulation borders could be automated, with alerts sent to the deconflicter upon detection of violations. If possible, the latter solution should be implemented as part of the automated interface between the simulations. Furthermore, General Saint, CINC USAREUR, mentioned that the interface between CBS and the WPC models was a high priority, since neither the WPC nor CBS will survive alone (primarily due to cost considerations).

Issue 5: The two overlapping GRWSIM games confused both players and controllers.

Discussion: The employment of two overlapping GRWSIM games was proposed to present a Red threat deep and to the flanks of each corps. During exercise preparation, the main concern was whether the activities between the two overlapping GRWSIM games could be coordinated. During exercise execution, the main question was whether the units in the field, the Blue and Red response cells at the WPC, and the controllers at the CENTAG control cell and the Exercise Control Center could all keep from confusing both the units and the events of the two overlapping GRWSIM games. The answer to this execution question was predominantly, but not exclusively, no. V Corps headquarters received data on the location of both Forward Line of Own Troops (FLOTs) in the games to its northern flank. Red and Blue response cells at WPC frequently became confused as to the events in each

game. Some Blue cells even reported they were moving "their" motorized rifle division in a given direction. Controlling the two games at the white cells became virtually impossible.

Moreover, because the two GRWSIM games were separated, there was a disconnection between the deep operations of one side and the corresponding rear operations of the other. This disconnection meant that neither corps could fully play out a major battle synchronizing its close, deep, and rear operations.

Recommendation: Although the attempt to run two simultaneous GRWSIM games was a worthwhile experiment, in retrospect it was a poor strategy. It is unlikely that, if repeated, the complexity and confusion engendered could be greatly reduced. In addition, the disconnection forced by the strategy between close operations on the one hand and deep and rear operations on the other risks compromising the synchronization of corps battlefield operating systems (a primary objective of the CS 90 exercise). The problem that the two simultaneous games attempted to solve—presenting deep and rear opposing force threats to two Blue forces fighting a close battle against each other—still needs to be solved. It may be that, for corps-level exercises, the basic scenario design is flawed and needs to be revised. The final report will discuss the proposed design of REFORGER 92 and the problem of the "color" of the threat facing the training audience.

Issue 6: The continuous simulated battle over the transition weekend took a great deal of effort and was unrealistic.

Discussion: During many large FTXs, the weekend in the middle of a two-week exercise is called the transition weekend. The side that was attacking goes on the defense, while the defending side goes on the attack. The transition is traditionally performed in the administrative (nontactical) mode.

During CG 89, the control staff experimented with playing through the transition weekend with the simulated (WPC) units fighting, while the FTX and CFX units transited in the administrative mode. The idea was to present a continuous picture to the corps staff. Simulated divisions passed through real divisions on Friday night, and vice versa by Monday morning.

The experiment was repeated during CS 90 on a larger scale. Not only were there more simulated and live units involved, the event was played in both GRWSIM simulations. So as not to confuse "real" with "simulated" units, the V and VII Corps staffs were temporarily split and artificial staffs with artificial names created in order to control the simulated units fighting during the transition. This split led to considerable confusion. At one point well into the weekend, we observed the CENTAG Assistant Chief of Staff for

Operations talking with elements of both V and VII Corps staffs for over an hour explaining the responsibilities of the artificial corps staff for the transition weekend. The simulated unit response cells were reshuffled to handle the increased load. Some of the reconfigured response cells had three people handling two divisions represented at company-level resolution. Both the Red and the Blue response cells were stretched much more than expected. As a result, the two corps staffs agreed between each other, with control staff approval, to not attack each other in the north (the weekday simulation box), but focus on the south (the weekday CFX/FTX box).

The entire weekend exercise suffered from a lack of realism. A whole corps is rarely entered into the line in two days, much less removed again within that time period. It appears that the desire to present a continuous picture to the corps had driven the scenario into an unrealistic direction. As a result, the demands on both the live and simulated staffs appear greater than might be reasonable, given they are executing two corps-sized passages of lines in 48 hours.

Recommendation: The main question is whether the option to play through the weekend with the simulation, as currently configured, is worth the effort, given the confusion and lack of realism. The two alternatives are either to return to conducting the transition in administrative mode or to make the scenario for the weekend transition easier to comprehend and more realistic. The former option is the least expensive, but may not meet all of the training objectives of the exercise. The latter alternative should probably be favored, as the exercise benefit to corps staffs of having to maintain a battlefield pace for more than five days is great.

There are several ways to improve the weekend scenario. One option is to employ fewer live forces, so that the size of force being passed onto line and then off again within 48 hours is more reasonable. This option is less expensive with respect to vehicle and personnel operating costs, and would demand fewer simulation support personnel to represent a smaller force. Another option is to shift the corps boundary so that the training corps is given operational control of additional simulated forces for the transition weekend. If the simulated forces are already participating in the exercise, then there is no additional expense for this option.

Issue 7: Actual unit staffs performed better than ad hoc unit staffs as training support augmentees.

Discussion: The employment of a full staff that has trained together tends to perform better than "ad hoc" staffs that are assembled just for an exercise. In addition, many of the

ad hoc personnel are not trained in the areas they are attempting to support in the exercise. As a result, the quality of training support provided by ad hoc staffs is lower than if an actual existing staff were employed, as we observed during CS 90.

Recommendation: Large-scale exercises such as CS 90 provide an opportunity to develop and exploit existing staffs as training support personnel, rather than continuing to rely on ad hoc staffs for training support. For example, a National Guard and a French unit each participated as a response cell at the WPC during CS 90; this practice could be expanded upon in future exercises. The absolute cost of the exercise would increase slightly because of the involvement of more units as a whole (rather than individual personnel), but the relative training cost to all of the units could decrease because of the benefits of training a full unit staff in a single operation.

A potential drawback to this strategy could be the increased cost of bringing the additional units to Europe for the exercise. The additional cost could be overcome by maintaining satellite communications boxes in the contiguous United States (CONUS) at an appropriate Army or joint agency. There are many National Guard and Reserve units in CONUS that would be willing to participate in these exercises, especially if they are 24-hour-a-day exercises (so that the time difference between Europe and CONUS is not a burden). This option could also support the CAPSTONE program for Reserve and National Guard training. With the advent of distributed wargaming capabilities, it is relatively easy to connect the units to WPC exercises by satellite. As long as the cost of the satellite communications is already incurred, connecting more distant locations by satellite is only marginally more expensive. The satellite communications boxes on the ground could be controlled in CONUS by another Army or joint agency, such as the Joint Warfare Center (JWC).

As a final consideration, there may be a number of active units currently stationed in Europe that will be returning to CONUS. The satellite linkages would enable these units to continue to be trained together with their European counterparts. A precedent for this was set during earlier exercises, including the ACE 89 exercise, in which the U.S. III Corps participated from its home station in Texas.

Issue 8: Simulated headquarters were inadequately staffed.

Discussion: The original plan was to have at most six simulated divisions active at once. It turned out that ten simulated divisions were active at the same time during this exercise. The additional burden exceeded the capacity of the WPC staff and augmentees; at one point, three people were running two simulated divisions at WPC. The steps taken to

keep the exercise running had negative effects on training, both in terms of presenting unrealistic situations and in degraded command-and-control.

For example, during the weekend transition, it was agreed between the Blue and Red simulation commanders, and approved by the control staff, that because of the WPC staff shortage, neither side would attack in the north until the end of the weekend. As a result, the northern flank was completely stagnant for that time. This not only had the direct effect of portraying an unrealistic battle, but made for extra work when the northern flank came back into action, in order to make action there consistent with the results of the weekend battle. For example, even though the northern front was stagnant, the southern front was active and the FLOT was moving, leading to the possibility of exposed flanks.

The direct effect on command-and-control was perhaps even more serious. For example, when operational control of the 159th (simulated) Division was passed to V Corps headquarters, the response cell did not have enough personnel in each staff function to coordinate directly with the corresponding staffs in V Corps, leaving V Corps unable to fully exercise its vertical synchronization with a subordinate unit.

Note that in discussing this issue, we are concerned only with communications between simulated units and the training audience. The size of staff necessary to run a simulated unit using current detailed simulations is considerably greater than the number of personnel required in a response cell to simply communicate with the training audience. A brief description of the personnel required to man a response cell is presented below.

Recommendation: Require sufficient response cell staff at simulated units to at least communicate with the real unit staffs. Part of the difficulty in staffing the simulated headquarters is that current training simulations are very manpower intensive. As a result, there is a tendency for the simulated unit response cells to be undermanned, which puts them in reaction mode and allows little, if any, time for planning. One solution, mentioned above, is to employ intact command staffs to play simulated units. To the extent that time and cost limiting factors permit, this is the best solution. But when such staffs are unavailable or would be prohibitively expensive to put into place, then an ad hoc staff is required. When an ad hoc staff is used, minimum staffing levels must be provided; otherwise there is little benefit to the exercise by including the simulated unit.

Adequate staffing of simulated units is no small task. The minimum staff necessary *solely for purposes of communication* to a corps is nine per shift, specified as follows: two people for each of three divisions (a combat communicator who combines G2 and G3 roles and a combat support communicator who acts as a master Fire Support Cell (FSC), communicating indirect fire, air force support, army air defense, and army aviation); one

person for the Armored Cavalry Regiment (ACR), and two people for the diverse separate corps brigades. If combat service support is to be thoroughly played, additional staff personnel are necessary. This staff must produce reasonably realistic plans and communicate those plans to the training audience and controllers. Some of the simulated unit plans and overlays may be prepared ahead of time and modified to adapt to the local situation. Unless some of the personnel in the response cells have as their primary duty the standard staff communications with the training audience (rather than being responsible for running the simulations), the training audience is not presented with the interactions they would have with a "live" unit.

Issue 9: There was insufficient preparation time for augmentees.

Discussion: An exercise of the magnitude of REFORGER requires a large number of augmentees, or temporary staff, to supplement the basic simulation center support staff. For example, the ratio of WPC personnel to augmentees was about 1:20. It is important to provide adequate training for the augmentees for the tasks they will perform and to provide them with all of the materials that they will use in the exercise. In CS 90, many of the training support personnel were not initially provided with all of the material and training necessary to adequately support the primary training audience. For example, the augmentees simulating adjacent corps (LXXIst and LIXth) had no corps operations order, and received Army Group guidance only two days before STARTEX. Neither were the simulated corps provided corps operations order from the training audience corps; therefore, their plans were not coordinated.

Similar staffing difficulties were faced by Air Force augmentees. For example, the personnel assigned to a simulated Air Tactical Operations Center (ATOC) had no ATOC training. The WPC was set up only to train personnel in how to operate the simulations, so the Air Force augmentees were taken to Sembach Air Base for a briefing on ATOC operations. In addition, there was no air campaign plan prepared as part of the scenario for the simulated Air Force positions.

Recommendation: Better advanced planning must take place to ensure that augmentees receive the necessary materials and training. Although the nature of major exercises precludes preparing augmentees for anything they might face, it is possible to provide training in the tasks that they will be required to perform. This training should be hands-on if at all possible, so that the augmentees can develop a feel for their tasks. In addition, the augmentees should be provided the basic materials necessary for planning, such as maps and overlays, and be provided an overview of the exercise. It would also help to

have the exercise simulations begin before STARTEX so that any bugs can be worked out and possibly unforeseen training and material needs provided.

Issue 10: For this corps-level exercise, the adjacent simulated corps and divisions did not capture the attention of the training audience.

Discussion: One difference between CG 89 and CS 90 was that the primary training audience in CG 89—V Corps—had responsibility for all Blue units—whether in the field or simulated—employed in the exercise. In CS 90, on the other hand, there was a simulated corps flanking each of the primary training audience corps. During the exercise, no one in the training audience staffs seemed to care much what was occurring in the simulated flank corps. Because the two respective flank corps faced each other in the northern part of the exercise box, there was nothing in the scenario that forced the training audience to take a vital interest in what was occurring in that area.

It appears that having a simulated division that is owned from the outset by the corps being trained holds the interest of the corps staff. Simulated divisions that were an integral part of the corps attracted full corps staff attention. But when operational control of a simulated division was passed from the simulated corps to V Corps, the necessary interest by corps staff was not generated. This could be because there were not enough people staffing the simulated division staff positions to properly coordinate actions (see Issue 8, above). Moreover, the close operations map at V Corps was positioned so that the location of this division was not readily visible; hence it was easy to ignore.[4] For perhaps all of these reasons, there was only minimal coordination between the training audience and simulated divisions.

Recommendation: The considerable effort that is needed to fight the flank corps seems to have been wasted. Scripted information presented over time would have been sufficient to meet the needs of the training audience corps staffs. Great savings in terms of the demand on the WPC systems and personnel can be gained by this simplification. A small EAC scripting cell (from CENTAG for an exercise like CS 90) can manage the theater picture and, indeed, tailor it to the training needs of the audience. For example, over 200 augmentees were required to support the WPC simulations during CS 90. Most of these augmentees were employed running the flank simulated corps and their opposing forces. Since neither the simulated flank corps nor their opposing forces had any significant impact

[4]This map problem is more appropriately addressed to the corps staff than to the exercise direction. But in the pre-exercise discussions, care should be taken to let the corps know that it *could* have to assume control of sectors other than its original one.

on the training audience, less manpower-intensive simulations should be considered for providing inputs from adjacent simulated corps. This will significantly reduce the costs of the exercise while providing the same level of training benefit to the training audience.

Furthermore, any simulated divisions that will come under the control of a training audience corps during the exercise should be sufficiently manned to be able to coordinate with the corps. The exercise structure should not impede efforts by the corps to establish linkages with the division. Then, deficiencies identified will likely be items for the corps to improve, rather than artifacts of the exercise.

Issue 11: The force ratios were poor for attack scenarios.

Discussion: The correlation of forces was never sufficient for a scenario for either Blue or Red forces on the attack. The force ratio in the CFX/FTX was about 1.2:1. In the simulated corps sectors, the force ratio was very close to 1:1. Neither Blue nor Red doctrine support launching an attack with such unfavorable ratios. The effect of the poor force ratio is actually less severe in the CFX/FTX box, where casualties are returned to "live" status in three or four hours.[5] As a result, the force ratio in the CFX/FTX box remains fairly constant, in spite of casualties. However, the simulations do not usually return casualties into the simulation to fight again. As a result, a poor attack force ratio leads to a failed attack.

Recommendation: In an exercise such as REFORGER, where Blue-on-Blue live forces alternate between attacking and defending roles, there are no entirely satisfactory solutions; the adopted practice of quickly returning "casualties" to action mitigates the effect of low attack ratios and keeps all the exercising troops in training as well. For simulated forces, though, there is no requirement that the same quantities be used in attacking and defending postures. During the weekend changeover, it is easily possible to take simulated forces away from the previous attacker and give forces to the previous defender to facilitate the change of posture. As long as the CFX/FTX box is separate from the CBS or WPC boxes, the addition and subtraction of simulated units should not pose a problem to the coherence of the exercise. There is no increased exercise cost involved with this recommendation.

Issue 12: The portrayal of the threat to the deep and rear operations cells was hindered by unforeseen scenario limitations.

Discussion: At the start of the exercise, the portrayal of the threat presented to the deep operations cells appeared to be working very well. However, after the initial reserve

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[5]The major reason why attackers require high force ratios is that they take more casualties than defenders. Returning casualties to action mitigates the effect of the losses.

forces were committed, remaining uncommitted threat forces were stationed beyond the reconnaissance interdiction planning line (RIPL). As a result, after the first three days of the exercise, there was little threat presented to the deep operations cell. There was no aspect of the scenario that presented the deep operations cells with a penalty for not tracking and engaging deep enemy units. Since the simulated units could not become "live" units, there was little menace the simulated deep units presented to the live corps area of operations. In addition, the coordination between the Blue and Red unit actions in the two parallel GRWSIM games was not accomplished except in a few cases early in the exercise. For example, in only one case for each live corps did a Red follow-on division in one GRWSIM game get committed at the same time as a corresponding Blue follow-on division in the other GRWSIM game. As the confusion between the two games grew over time, what little coordination existed between the two GRWSIM games dwindled to nothing.

The threat presented to the rear operations centers was limited, but not through lack of effort. For example, there were two attempts at inserting light infantry forces into the rear areas (one for each corps) in order to present a rear area threat. However, for a variety of reasons, these insertions were assessed to receive significant attrition (about two-thirds of the force in each case) before reaching the landing zone. Thus, significant rear area threats never materialized during the exercise.

Recommendation: The scenario must be modified to present a realistic and continuous threat to the deep and rear operations cells. In the case of the deep operations cells, additional follow-on forces need to be close enough and ambiguous enough to require careful monitoring. For any part of the training audience, there must be a perceived penalty accrued from the approach of enemy simulated units into the live exercise box. In the case of the rear operations cells, a rear area threat might be inserted from the flanks in order to present a credible threat development story without inserting them as if by magic. See issue number 47 for further discussion of options for presenting realistic threats to the rear areas.

Issue 13: The scenario was unclear about whether the reserve divisions were national assets or NATO assets.

Discussion: The 170th (simulated) division was told it was a U.S. national asset at the start of the exercise. However, passing operational control of this simulated division to VII Corps required going through the steps of handing a NATO asset to a U.S. corps. This created confusion at the Army Group, corps, and division levels.

Recommendation: Ensure that the scenario is detailed enough to address whether simulated units are national assets or NATO assets. Overall, we predict that the training of

procedures between U.S. and allied forces will become more strongly emphasized. This trend will continue as the various options for multinational corps are considered and evaluated.

III. ISSUES BY FUNCTIONAL AREA

In this section, we analyze issues with respect to the functional areas identified by the Exercise Directorate, USAREUR as important to the success of CS 90. Each of the functional areas is a necessary ingredient of a corps battle; hence the exercise must provide an adequately realistic representation of the battlefield for each functional area.

Our observations were largely of the simulations and selected interfaces among exercise modes. In some cases, one problem in the exercise seriously affected more than one functional area, so we discuss the problem in two separate issues. Although this results in some duplication, we chose this tactic because we believe that some readers will wish to focus their attention on some functional issues and not others. Where an issue falls largely in one functional area, we cross-reference other allied issues by number. Issues 14 through 47 are grouped according to the following functional areas.

- Unit resolution (and passing information back and forth)
- Command-and-control (C2)
- Air
- Air defense
- Army aviation
- Joint Suppression of Enemy Air Defenses (JSEAD)
- Electronic Warfare (EW), including signals intelligence (SIGINT), electronic intelligence (ELINT), and countermeasures
- Threat play
- Intelligence
- Deception
- Corps picture
- Close operations
- Deep operations
- Rear operations
- Fire support (non-air)
- Combined arms[1]
- Engineers
- Signal
- Combat Service Support (CSS)
- Airborne/air assault

[1]Long-range surveillance units, special operations forces, and Spetsnaz teams are also addressed in this subsection.

UNIT RESOLUTION

Issue 14: The accuracy of the location of friendly and enemy units differed among training modes.

Discussion: In the field, it is often difficult to determine unit location, whether it be friendly or enemy units. Even in CFX mode, where a company might be represented by a single vehicle, determining a friendly battalion's center of mass can be difficult. In most simulations, however, determining a battalion's center of mass is easy.[2] This facilitates bookkeeping by the simulation center staff and decisionmaking by the staffs of simulated units, but overly simplifies the task of units in the field. In addition, most simulations assume all of the locations of friendly units are precisely known, and also assume that if an enemy unit is detected, all of the friendly units are simultaneously aware of its location. This ability to instantly pass information accurately among all friendly forces is not realistic but is a common occurrence in current combat simulations. To conduct CS 90, the live units in the field had to be represented in the GRWSIM games. This was accomplished by taking approximately 1700 CFX/FTX units with uncertain locations and representing them by 250 simulation "icons" each with precise locations.

Recommendation: In the long run, if mixed-mode simulation/live force exercises are going to be used for training, then the extraordinary location accuracy associated with simulations must be degraded to improve the training exercise realism. Otherwise, staffs will be trained in an unrealistic setting where both friendly and enemy unit locations are well known. The BCTP method of isolating the primary training audience from the simulation system by forcing all communications between computer systems and the audience to pass through major subordinate command posts in the field goes a long way toward solving this problem in purely simulated exercises. Other solutions may be based on making the simulated ground representation more realistic by employing area units on digitized terrain rather than as point units on hex-based terrain.[3]

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[2]In the simulations, the battalions, companies, or batteries are represented as points, making the center of mass calculation fairly easy.

[3]The problem here goes well beyond the scope of this Note. A discussion of the notion of area units and digitized terrain can be found in P. Allen, *Ground Model Examination Methodology*, The RAND Corporation, forthcoming.

C2

Issue 15: There was confusion early in the exercise because the simulated C2 structure was not well understood.

Discussion: The awkward C2 structure, and in particular the two GRWSIM games overlaid upon the same terrain, caused confusion early in the exercise and during the weekend transition period. The C2 structure in CS 90 was improved since CG 89 in that who was supposed to report to whom was better defined before STARTEX. However, confusion in the simulated command structure continues to be a major problem in the execution of mixed-mode exercises.

Recommendation: We reiterate here the recommendations on C2 made as a result of our observations of CG 89.[4] Ensure well before the start of the exercise the answers to the following:

- The training audience (including specific persons by name, simulated position, simulated rank, and exercise phone number).
- The specific tasks in which each training audience is being trained. Also specify tasks in which the training audience is not being trained, so that expectations are prepared ahead of time.
- The identification of training support personnel, and whether any collateral training is being attempted. Prepare expectations before STARTEX.
- Who is in charge of information flow into and out of the training audience. There needs to be a focal point to monitor information flow into and out of each training cell, to ensure that the training objectives for each cell are being met. The observer/controllers of the BCTP warfighter exercises usually provide this function.
- In addition, specify persons to act as the point of contact for personnel being trained to determine whether a specific event is part of the training plan or simply a simulation error or artificiality. The ability to contact a person knowledgeable about the current training plans is essential to prevent negative training.

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[4]See N-3151-A.

AIR

Issue 16 (*): The distinction between AWSIM air and CBS air was much better defined and implemented than previously.

Discussion: The determination of which simulation will play which aspects of the air war was determined early and employed successfully in CS 90. For example, CBS represented the CAS and Army aviation flying over their box, whereas AWSIM represented all other air outside of the CBS and CFX/FTX boxes. Assessment of WPC aircraft other than CAS and Army aviation flying over the CBS box is described in Issue 19.

Recommendation: Ensure that air continues to be satisfactorily coordinated in subsequent exercises.

Issue 17: The live and simulated air operations were not well integrated.

Discussion: Live aircraft could fly against live ground forces only as part of the U.S. Air Force Cold Fire exercise in support of CS 90. This restriction was instituted to ensure that pilots received good training while supporting the exercise. As a result, if simulated targets appeared, simulated aircraft had to be allocated against them. This worked well when live ground targets were available to live aircraft, or when simulated targets were available to simulated aircraft. However, if a corps was apportioned a number of live aircraft and only simulated targets were available, two artificialities occurred. The first is that the live sorties were "traded in" for simulated sorties of an adjacent headquarters so that the simulated targets would be hit. The second is that the live aircraft still needed to fly to accomplish their training hours, so they were flown against shallow live targets in the CFX/FTX box.

Recommendation: An option is to reduce the restriction of live aircraft flying only against live targets. The aircraft could be flown against particular geographical locations. In addition, one could set up a few "live" mobile targets at particular locations for the aircraft to fly against, and the results applied to the actual target location desired.[5] Moving the mobile targets periodically would ensure that pilots would fly a variety of missions. The cost of locating a few vehicles to provide targets for aircraft missions is not large, especially when one considers that they would have to move only a few times each day.

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[5]A target used in this manner is called an "offset" target.

Issue 18: The flight of simulated aircraft was as restricted by weather as that of actual aircraft.

Discussion: The weather used in CS 90 was the actual weather in the field. As a result, the restrictions on aircraft in the simulations were similar to the restrictions in the live exercise. For example, although the representation of attack helicopters was faulty in GRWSIM (see Issue 22), the sortie rates were realistically restricted by the weather conditions. Fixed-wing aircraft sorties were similarly restricted.

Recommendation: Continue to decide before STARTEX whether the simulated weather will reflect the actual weather conditions. If the focus of training is on air-to-ground mission planning and coordination procedures, then simulated weather could be always perfect and the training objectives still met. If the training goal is to present a realistic situation in which aircraft may not be able to reach a vital target because of climatic conditions, the weather should be represented as a reflection of real weather conditions. There is no additional cost incurred by simulating clear or adverse weather conditions.

AIR DEFENSE

Issue 19: Air defense assets were well coordinated among simulations.

Discussion: The separate representation of air and air defense assets between the CBS and WPC simulations was well coordinated. In the case of CBS, air defense assets included only short range air defense (SHORAD) over the CBS box. All high and medium altitude air defense (HIMAD) over the CBS box was handled in AWSIM. Any SHORAD in the GRWSIM box covered only the ground forces in the WPC models.

Recommendation: Continue the coordination of air and air defense assets between simulations in future exercises. The only additional costs incurred by implementing this recommendation is the time required for the coordination.

Issue 20: Simulated ASOCs were not informed of damage against penetrating aircraft.

Discussion: The simulated ASOCs represented at the WPC were not receiving information on the number of enemy aircraft engaged or destroyed. As a result, the simulated ASOC personnel were unsure whether they were having any effect early in the exercise; in turn, the air liaison officers could not carry a picture of the air war to the corps primary training audience. For CS 90, WPC personnel provided an emergency fix to the problem by hand-carried printouts giving the previous engagement results to the simulated ASOCs.

Recommendation: The recommendation here is straightforward: provide the simulated ASOCs information corresponding to what real ASOCs would receive. This information is readily available in the simulations, as evidenced by the ability of the WPC to provide the information in an ad hoc manner. The larger recommendation is to think through the communications that will take place during the exercise to make sure that all elements providing information to the primary training audience have a basis for obtaining that information. The only costs incurred by implementing this recommendation is the time to obtain and provide the necessary information to the ASOCs. If one wishes to automate the information, the costs may involve the use of additional computer terminals and the necessary communications links.

Issue 21: Live corps air defense assets were not involved in the air conflict.

Discussion: Live corps air defense units had a series of good-news bad-news items. The good news is that they were perfectly deployed. The bad news is that they could not shoot any enemy aircraft. The good news is that they could not be hit by enemy aircraft. The bad news is that they could not protect friendly ground forces from enemy aircraft. The good news is that nothing in the rear was getting hit anyway. The bad news is that the FLOT forces were getting hit fairly consistently. As a result, the representation of air defense in the CFX/FTX was not effective training for the air defense personnel.

Recommendation: Mechanisms for the interface between live air and air defense assets need to be created. The subject is important and needs increased priority so that it comes out of the "too hard to do" box. One possibility is to look into the SYNADEX (Synthetic Air Defense Exercise) methodology or its follow-on system, and determine whether it could be implemented in support of a live-fly/live-ground field exercise. This long-term option would probably be expensive if actually implemented, but may be worth the increased training benefit.

ARMY AVIATION

Issue 22 (*): Simulated Army aviation in GRWSIM was not realistic.

Discussion: By far, the majority of the Red forces eliminated were destroyed by Blue attack helicopters and only secondarily by Blue multiple launch rocket system (MLRS) assets. This is because the Blue attack helicopters in GRWSIM were represented as being extremely lethal, invulnerable to Red air defenses, and suppressed only by bad weather. As a result, a few AH-64s could destroy a whole tank regiment in a single mission. A large formation of helicopters, unencumbered by stacking limitations, could leave a swath of

devastation wherever they flew. These results are patently unrealistic and caused ridiculous losses to Red forces. For example, 47 out of 53 maneuver battalions in a Red division were completely destroyed in two days solely by Blue attack helicopters and MLRS. (The remaining six maneuver battalions were at half strength.) Losses due to Blue maneuver units were relatively trivial in this exercise. During the course of the exercise, a modification was made to increase the SHORAD lethality and reduce the vulnerability from air attacks for units on the defense. But since Red units were not allowed the same benefits of the "defend" posture as the Blue units (see Issue 26), this did not succeed in solving the problem.

Recommendation: In the short term, the current Army aviation parameters in GRWSIM need to be corrected. Some effort has been made along these lines, but even in exercises subsequent to CS 90, attack helicopters and artillery caused over 90 percent of the total attrition on the battlefield. In the long term, some sort of data base configuration control should be implemented. There is already a configuration control system applied to the model code, but no such system applied to the model parameters and data base. Data base configuration control can be applied through improved procedures at little additional cost.

JSEAD

Issue 23: Little JSEAD was played in the simulations, with very limited results.

Discussion: The only JSEAD operations planned for the exercise were to implement through controller intervention a reduction in enemy air defense capabilities for selected operations. These options were initiated only once in support of the deep insertion of heliborne forces into the enemy rear area. This event raised three issues. The first is that the JSEAD operation itself did not extend as deep as the selected landing zone, so that losses to penetrating transport helicopters were high. The second is that most of the transport helicopters were assessed to be hit by visual and infrared guided air defense assets. Therefore, the electronic warfare (EW) portion of JSEAD had no effect on these air defense assets. The third issue is that no attack helicopters were allocated to the mission to suppress the visual and infrared air defense assets or enemy ground forces in the vicinity of the landing zone. Apparently, the proper number of the right types of helicopters was not available, leading to a substitution of different types of helicopters. This made the subsequent assessment by umpires difficult, since not all were informed of the substitution process.

Recommendation: We distinguish between the effect of a JSEAD strategy and its implementation. Pre-exercise deliberations need to conclude whether JSEAD and deep insertion operations will be employed based upon the availability of appropriate assets. If such assets are not available, then control-implemented alternatives should be agreed upon, such as trucking the insertion force to the "landing" zone to stress the rear area forces. All of this will have an effect on the conduct of rear operations.

A perhaps more critical recommendation is that JSEAD should be an integral part of the exercise. The growing experience of corps-level battles, most recently at the JWC, WPC, and BCTP, emphasize the importance of Army/Air Force coordination in the suppression of enemy air defenses. An exercise of the magnitude of CS 90 must have a major provision for the training of this function if it is to be a credible representation of corps battlefield behavior. The costs required to fully implement this option in the long term are likely to be high. However, as mentioned in issue number 21, the long-term benefits of such an option are also likely to be high.

ELECTRONIC WARFARE (Including SIGINT, ELINT, and countermeasures)

Issue 24: Very limited EW was played in this exercise.

Discussion: There was no representation of detection and subsequent targeting of electromagnetic emitters in general. Tactical radars associated with fire support could operate without penalty. There was no penalty for not following good emission control procedures. In the CBS box, there was a combat electronic warfare and intelligence (CEWI) battalion assigned to the 194th Separate Armored Brigade. Although the model could not automatically provide the information they needed, the model controllers were able to manually provide the CEWI battalion with the types of intelligence collection reports they would normally receive.

Recommendation: The simulations do not appear to represent EW effects except for air and air defense activities. This is one area where the expectations of the participants need to be prepared before the exercise. Some monitoring of the electromagnetic spectrum may be accomplished in the CFX/FTX so that appropriate responses can be employed in that training mode. However, until the simulations are significantly improved in this functional area, attempts to train through these training modes should be kept to a minimum. In addition, the WPC and CBS personnel have requested a definition from the ground EW and electronic combat organizations of what they expect to achieve, how, and under which

conditions, so that the simulations can be improved in those directions. Both the long-term costs and benefits of this option are estimated to be high.

THREAT PLAY

Issue 25: The balance between Red and Blue logistics and intelligence capabilities was appropriate.

Discussion: During CG 89, it was noted that there were unbalanced representations of Blue and Red capabilities. For example, Red forces were virtually unconstrained in resupply whereas the Blue forces were constrained in resupply capability.[6] Conversely, Blue was receiving extensive intelligence on Red forces, whereas Red was receiving little intelligence information on Blue. These discrepancies were noted and were more balanced in CS 90. For example, although the original intent was to constrain the resupply of both Red and Blue forces, this could not be accomplished for Red. Therefore, Blue GRWSIM forces became unconstrained in CS 90, thereby balancing the resupply representation on both sides. Similarly, intelligence information was relatively balanced for both sides.

Recommendation: It would be better if both Blue and Red resupply rates were realistically constrained, but this will require additional staffing in the Red response cells. In the absence of additional Red-cell staffing, automatic resupply is more balanced, but it also limits the training benefit to the G4 staff elements. The increased costs of implementing this recommendation are proportional to the number of personnel required to represent constrained logistics for the threat. In the long term, we recommend the development of models that automatically represent a constrained threat logistics activity. The long-term recommendation involves a higher investment cost but a lower operating and manpower cost.

Issue 26 (*): In GRWSIM, Red units were not allowed the same benefits of the defend posture as Blue units.

Discussion: In GRWSIM, Red forces were not allowed the same benefits as Blue forces when in the "defend" posture. For example, Blue forces on the defense automatically engage enemy forces passing adjacent to their hex.[7] This allows Blue to prepare a cohesive

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[6]There is a restriction on Red resupply rates of a maximum of 25 percent of their basic load every four hours. However, since the basic load parameters are high, Red is almost never constrained by the model in ammunition or POL. In addition, artillery fire rates are virtually unconstrained, since they are pulling from a large stockpile that is assumed to provide ammunition at the right place and time, causing no congestion on the roads while delivering the ammunition. It also assumes that Red has all of the trucks it needs ready and available to transport supplies.

[7]This is called the "auto-defend" posture, which Blue units may be ordered to enter. In addition, the model automatically places Blue units into the auto-defend posture if they have been stationary for more than an hour.

defense line by placing forces only in every third hex. Red forces, however, are not allowed to be in this auto-defend mode, and therefore are not allowed to stop enemy units passing through an adjacent hex. Instead, the Red units must be manually ordered to engage the opposing unit before it has penetrated the defense line.

In addition to the tactical asymmetry this induces, the lack of an auto-defend mode greatly taxes Red workstation operators, each of whom must order the actions of up to 90 separate units. The problem is further exacerbated because Blue units are usually company-sized whereas the Red units are usually battalion-sized (see Issue 27).

Furthermore, there is a question as to whether the model provided Red forces the increased strength benefit from remaining in defensive positions or the improved air defense capabilities that should accrue for units that are stationary and deployed. Blue units receive a 33 percent increase in combat strength if in place for more than three hours. Red units are supposed to receive a similar, although possibly smaller, percent strength increase while on the defense, but this could not be demonstrated either during or after the exercise.[8]

Other examples of possible misrepresentation of Red capabilities are in attrition and maneuver (such as the problem with attack helicopters discussed in Issue 22).

This unbalanced representation had a significant effect on the play of the Red forces, causing them to behave unrealistically. These unrealities in turn had a negative training effect on the Blue staffs, because they were reacting to an unrealistic threat.

Recommendation: A realistic representation of both Blue and Red capabilities is necessary to achieve proper training support. Artificially handicapping Red may make Blue's life simpler in the exercise, but risks inducing bad practices and false expectations. The particular problem here involving Red defense is especially serious in times when the Soviets and other potential threat forces are moving toward a more defensive doctrine than in the past. Similarly, giving Red an unfair advantage against Blue, such as virtually unlimited supplies, is equally unrealistic. In general, there is no additional cost in designing simulations with balanced and realistic (but certainly not identical) capabilities on each side.

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[8]During the exercise, Red players observed that Blue units appeared to be gaining strength on the defense, while Red units were not. After the exercise, the GRWSIM programmers explained that increases in strength due to being in the defense posture are buried in the code and are not displayed. However, the programmers could not demonstrate that the Red units actually received a benefit while on the defense. It was suggested that a difference in reconstitution produced the observed difference; Red units are not allowed to receive returns from their own maintenance in the GRWSIM model, whereas Blue can. If the latter is true, questions arise regarding the accuracy of the representation of reconstitution for engaged on-line units in GRWSIM.

Issue 27: Some Red and Blue unit sizes in the WPC simulations were inappropriate for the scenarios in CS 90.

Discussion: Red maneuver unit resolution was kept at battalion level, whereas Blue maneuver unit resolution was kept at company level. This works relatively well when Red is on the offense and Blue is on the defense. However, when Red is on the defense, the maneuver unit resolution is less appropriate. When Red is defending with battalions and Blue is attacking with companies, it is difficult for Red to spread out forces to cover the appropriate defensive frontage. Blue companies easily moved around and outflanked Red battalions on the defense. The problem for Red was exacerbated by the inability of Red to automatically engage Blue units in adjacent hexes (see Issue 26).

Recommendation: Unit resolution of both sides should be appropriate for the scenario being played. At the very least, they should be equal when Red is on the defensive. Changing Blue maneuver unit resolution from company to battalion would be the easy way to accomplish this from a technological standpoint, but it would probably be unpopular with Blue players, who typically demand greater, not lesser resolution. The alternative of magnifying Red unit resolution is costly; Red staffing is typically short as things are, with one Red person handing 90 different icons representing companies and battalions. There is no or marginal increased cost in implementing this recommendation. If Red units are on the defense, then each Red unit should be no larger than each Blue unit in that scenario. Although smaller Red forces would mean more augmentees for the *same size* of Red force, one does not usually launch an assault at a one-to-one force ratio (see Issue 11). Therefore, no increase or a very small increase in threat cell augmentees would be required to run a smaller Red force at the same level of detail as the Blue force.

INTELLIGENCE

Issue 28: The different update times and resolution in each training mode created difficulties in the intelligence functional area.

Discussion: During CS 90, CFX/FTX unit locations were reported by the umpires to the Umpire Control Center (UCC), which sent the data to the ECC. At the ECC, the CFX/FTX unit locations were entered manually into CBS, and then passed to GRWSIM through the simulations interface. Once units were in the WPC model data base, the Intelligence Collection Model (ICM) was run on that data base to detect unit locations, including the CFX/FTX units. Due to the delays associated with each step, the intelligence data on CFX/FTX units were at least two to four hours old by the time the corps G2 received any data on the CFX/FTX units. However, the data collected on the simulated units were

more continuous, as the computer updated unit locations about every 20 minutes. As a result, the intelligence cells observed that location data collected on the CFX units were quite "jerky," whereas the location data collected on the simulated units were more continuous. Therefore, it was unusually difficult for the G2 staffs to track the live units through the simulations.

In virtual contradiction to this situation, the CFX/FTX players came to rely more on the ICM reports passed to them from corps than on the live reports from actual sensors in the field. This is because the ICM reports were more accurate than the reports from the live sensors, in spite of the time delay. This apparent paradox can be explained when one considers that the ICM reports were on battalion-sized units, while the field reports were—essentially—on individual command vehicles posing as companies or batteries. The aggregation process engendered by the circuit through the simulations meant that a lot of random error on the individual vehicle level was reduced; hence the center of mass reported by ICM was, even though late, more accurate than the individual and noncomprehensive field data points available to CFX/FTX units. Another explanation of the apparent paradox, discussed in Issue 29 below, is that the fused-data mode of the ICM provides too much information.

Recommendation: The intelligence updating procedures need to be improved in future exercises. One option would be to employ only live intelligence collection assets in the CFX/FTX box. This would preclude reliance on the simulation intelligence outputs and force a greater reliance on live sensors. However, as discussed in Issue 31, there are inherent difficulties employing live intelligence assets in the CFX mode. In addition, if players become aware of the nature of the intelligence circuit, they can maneuver so as to take advantage of the induced artificialities and time delays. A longer term solution, even though at considerable cost, would be to employ a position location and reporting system in the command vehicles of CFX units.[9] This would allow a faster interface between live units and the simulations. If connected in this manner, the simulations could be better employed to assist in training selected functional areas.[10] The latter solution is more desirable, and may incur no additional costs if such position reporting systems become standard equipment in the U.S. Army. Otherwise, such position locating equipment would have to be provided

[9]This recommendation is discussed in N-3151-A.

[10]At the National Training Center (NTC), the position location reporting system is used to assess artillery fire accuracy. A similar assessment process might be arranged for intelligence collection assessment against CFX units in the field.

specifically to exercising units, similar to the MILES system currently employed in many training exercises.

Issue 29: Unadjusted ICM output is too detailed for exercises of the magnitude of CS 90.

Discussion: The ICM was originally designed for corps exercises to provide fused intelligence information to scriptors representing corps intelligence analysts, who would in turn pass the information to players. The combination of the ICM and the intelligence scriptors for the exercise replaced the intelligence analysts rather than training them. During CS 90, an attempt was made to include the intelligence analysts in the training audience. The raw output from ICM is not suitable for this training audience because it is overly specific. For example, the ICM fused representation of sidelooking airborne radar (SLAR) reports gives unit location and identification instead of the more realistic number of vehicles at the location that would be reported by that type of asset.

This problem could be overcome simply by employing ICM in its "detailed" mode rather than using its intelligence fusion capabilities. In the detailed mode, the information would be more like what the real sensors produce. However, the detailed mode would have required more intelligence analyst personnel than were available for the exercise. It was the intention of the exercise designers to have the intelligence cells filter the fused data to prepare realistic intelligence reports, thereby functioning as a response cell. However, the players in the intelligence cells, loyal to their parent units and informed that they were part of the training audience, provided their side with the best information available.

Even detailed mode ICM has major shortcomings in the way it interacts with simulations. Since GRWSIM locates units at the center of single hexes, and since this location is known to ICM, the intelligence report produces location accuracy of even large units to the tens of meters, when realistically the location of a unit might be known within perhaps 500 meters. Thus, in contrast to field reports which will vary in accuracy and uncertainty, an ICM report will either not see a unit at all or will report it to the highest possible accuracy.

Recommendation: In the short term, because it appears unrealistic to expect intelligence players to deliberately withhold information from their parent units, we recommend that the ICM outputs not be made available directly to the players. Instead, a training support cell of trained intelligence technicians will modify the ICM outputs into realistic intelligence reports for the training audience. The intelligence response cell personnel must thoroughly understand that they are not the training audience but training

support personnel for this exercise. This strategy has been successfully employed in BCTP corps- and division-level CBS-driven exercises.

In the long term, the ICM needs to be significantly modified to provide more realistically fused data. In particular, a new ICM must represent the doctrinal aspects of handling uncertainty, as well as the unique collection advantages and restrictions, for each class of sensor. A proposal has been made by a German firm to apply their rule-based fusion approach to the WPC's intelligence collection model. In addition, the representation of location uncertainty for detected units should be a major feature of the improved intelligence collection model. Neither of these long-term options is an inexpensive investment, but both promise improved quality of training and lower manpower costs once the process is automated.

Issue 30: The management of "magic moves" needs to be tightened.

Discussion: In the course of an exercise, for a variety of reasons, controllers will move units instantaneously, in what is termed a "magic move." When this happens, an observer sees whole divisions move hundreds of kilometers in a matter of a few hours. Intelligence cells, when detecting this phenomenon, lose their desire to continue to work with something so blatantly unrealistic. There is little incentive to spend time and effort detailing the tracking of simulated units that suddenly teleport across the battlefield.

Recommendation: First, major magic moves should be kept to a minimum in any exercise where intelligence staffs are being trained. A good initial scenario will reduce the need for a large number of magic moves, but some will still probably be required. Magic moves may be more tightly controlled if the exercise directing staff automatically tracks their use. Code for such tracking used to exist in GRWSIM and merely needs to be reinitiated.

Second, when intelligence cells are active, a standard procedure should be to have the exercise directing staff inform intelligence players when magic moves occur. This courtesy, in addition to maintaining the willingness of the intelligence staffs to play their roles to the fullest, will reduce negative training induced when teleporting units must be tracked across the battlefield. There is no additional cost incurred by implementing this recommendation.

Issue 31: Intelligence representation does not work well in CFX mode.

Discussion: An important problem inherent in a CFX is that the play of live intelligence becomes significantly limited. It is much more difficult to find a single wheeled vehicle representing a tank battalion than it is to find an actual tank battalion. In addition,

when a scout does detect a single wheeled vehicle, is he detecting a tank battalion or a mechanized battalion? What is the strength and posture of the "force" he just detected?

Recommendation: This issue, important as it is, does not have an easy solution. In discussing Issue 28, we recommended fitting CFX vehicles with position location reporting systems. "Found" units could then be identified from their computer-maintained status (perhaps even with some reporting error thrown in). But, as we mentioned earlier, this is expensive in the short term and could only be implemented if the CFX were taking place in parallel with a simulation such as GRWSIM or CBS. It may be that most intelligence function training will be limited in the future to FTX or simulation, rather than CFX. For example, CBS operates with players at the same resolution as a CFX. Therefore, the CFX intelligence play might be able to improve by employing an interface between CBS and the live CFX units, or by designing future REFORGERs using only simulated units. Exercises with only simulated units are less expensive, but may lack sufficient training benefit in certain echelons and functional areas. This issue will be addressed further in the final report.

DECEPTION

Issue 32 (*): Deception operations were planned and executed by both V and VII Corps.

Discussion: Before the start of the exercise, both V and VII Corps prepared deception plans. In fact, VII Corps "leaked" a false operations plan to the opposing side before STARTEX. During the second week of the exercise, V Corps prepared a deception plan in which one brigade would attempt to represent four brigades while the remaining three brigades hid along likely avenues of approach. In addition, V Corps intelligence was assigned the task of monitoring specific locations to determine whether the VII Corps had taken the bait. This activity represents progress in deception planning; deception operations were not attempted in CG 89 or most earlier corps-level exercises. Because of staffing shortages, the two simulated corps did not prepare any deception plans.

Recommendation: Encourage employment of deception plans and operations at all echelons during all exercises. One way to do this is to design exercises so that there is the potential of positive gain from a successful deception operation. This, in turn, calls for ingenuity and expertise in deception on the part of the exercise directing staff. There is no additional cost to implementing this recommendation, except possibly the time to train the staff in deception planning and execution.

CORPS PICTURE

Issue 33: The corps picture was not seamless between simulations and live play.

Discussion: A desired objective in CS 90 was to have the interfaces between the live and simulated parts of the exercise be undetectable to the players, or "seamless." This objective was not attained. Perhaps the least seamless aspect of the exercise was the intelligence representation. Not only was the representation of intelligence collection distinctly different between training modes, but how the intelligence cells subsequently handled those distinctions also differed. In one case, for example, the Rules of Engagement governing actions between live and simulated units were employed by an intelligence staff to determine the identity of the unit advancing to the FLOT.

Part of the problem arises from the scenario, which presented the intelligence cells with little threat from the rear and flanks as described earlier. Other causes included the lack of realism in the ICM as well as the slow reporting times from the field for units in the CFX/FTX box.

In addition to intelligence, virtually all of the CSS was not seamless. At one corps, the rear command post dealt only with "live" CSS, whereas the main command post kept track of "live" and "simulated" CSS in parallel and independent parts. Moreover, maneuver was not seamless. The separate brigades within the CBS "box" operated relatively independently and were not well integrated into the corps battle. And, as noted above, flank units, playing across the seam, were virtually ignored by the training audience. Finally, problems with the representation of air between live and simulated parts of the exercise contributed to the perception of the seam. See App. B for a more detailed discussion regarding which functional areas were seamed and which were not seamed.

Recommendation: Although more careful attention to possible seams can be part of the exercise and scenario preparation, we believe it unlikely that a seamless mixed-mode exercise is possible within the foreseeable future. To the extent that seamlessness is taken as a necessary condition for a successful mixed-mode exercise, the potential value of such exercises is called into question. This is a major issue whose analysis goes beyond the scope of this Note, although conclusions will be presented in the final report.

CLOSE OPERATIONS

Issue 34: Close operations in the simulations need additional calibration.

Discussion: There is a question as to whether the close combat attrition rates in GRWSIM and CBS differ.[11] There is also a question as to whether either simulation's attrition rates are consistent with the Army's standard planning factors as defined in FM 101-10-1 and FM 101-10-2.[12]

Recommendation: Complete the attrition rate comparison between CBS and GRWSIM and compare those rates with the doctrinal rates expressed in FM 101-10-1 and FM 101-10-2. The cost of the investigation is not known. The main problem appears to be obtaining sufficient time from the few personnel intimately familiar with each simulation and coordinating the details of common assumptions necessary to make this comparison.

DEEP OPERATIONS

Issue 35: Due to scenario limitations, the deep operations cell was not sufficiently stressed.

Discussion: The deep operations scenario started out well, and for most of the first week the deep operations cells were presented an adequate threat. They were defining named areas of interest (NAIs) and target areas of interest (TAIs) according to doctrine, and generally tracking the threat units. However, after the initial (simulated) enemy reserves were committed, there ceased to be a deep threat for the deep operations cell to monitor. Red forces were either committed to close operations or they were out of the corps area of influence or interest. For example, since live aircraft could not fly against simulated targets, when enemy forces appeared in the rear of the flank simulated corps the targets had to be passed to the adjacent simulated corps.

Recommendation: Drive the deep operations cell with a Red follow-on presence throughout the exercise. See Issue 12 for further details.

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[11]Comparing different attrition methodologies is more difficult than would appear on the surface. For example, CBS distinguishes between day and night combat, and between good and poor weather conditions. GRWSIM appears to employ average daily combat rates and clear weather conditions. Furthermore, CBS employs a weapon-on-weapon combat assessment methodology, whereas GRWSIM employs a force-on-force or score-on-score combat assessment methodology. Simply defining which combat situations to compare and how to compare the results are not easy tasks.

[12]See Issue 46 for a similar problem with regard to consumption rates.

REAR OPERATIONS

Issue 36: Although attempted, there was little rear threat to either live or simulated corps in CS 90.

Discussion: There was practically no threat to the rear areas of either the live or the simulated corps. There was no air interdiction campaign into any of the corps rear areas. Almost all attention of both live and simulated corps was on the close operations. Attempts to force each corps to place additional attention on the deep and rear operations were not successful for a number of reasons. For example, the live heliborne forces in the CFX/FTX did not arrive with sufficient strength at either landing zone. Due to a lack of live targets, little air interdiction of the rear areas was flown.

Recommendation: To present a credible and sustained rear area threat, two options should be considered. The first is that enemy forces might be inserted into the rear area by control insertion on the flanks of the CFX/FTX box. For example, the forces could be trucked to a drop-off point near the flank of the corps receiving the insertion. Thus, the forces presenting a threat to the rear areas could be inserted without greatly stretching the credibility of the air defense forces. Second, to increase the incentive of mounting an air threat to the rear areas, dummy (e.g., foam rubber) logistics targets, such as supply points and convoys, could be set up for live aircraft to attack. This could be employed along with the offset technique described in the air section. See Issue 17 for more details. The cost of the dummy or even a few live vehicles would not be great, and the benefits in causing units to attend to their deep (for attack) and rear (for defense) areas would be considerable.

FIRE SUPPORT (non-air)

Issue 37: The Fire Support Cells (FSCs) received good training.

Discussion: In most CFX or FTX exercises, only about 25 percent of the fire missions executed get adjudicated because there aren't enough umpires.[13] In CS 90, however, a much larger number of umpires than usual were allocated to adjudicating fire support missions. As a result, better overall training was provided to the artillery functional area in CS 90. The cost of the increased assessment performance was a significant increase in the number of fire support umpires.

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[13]At the National Training Center (NTC) or Combat Maneuver Training Center (CMTC), a larger percentage of indirect fire missions are adjudicated. Even there, though, the lack of a MILES-equivalent system means that indirect fires do not receive the comprehensive adjudication of direct fires.

There were a few problems in assessing artillery fires in the rear areas. Even though there were more umpires assessing artillery fires in the close operations areas, there were still not enough umpires in the rear areas to assess the effects of deep fires. Therefore, even though long range surveillance units (LRSUs) and light infantry might locate and target an enemy headquarters, convoy, or supply point, there were no umpires available to assess the results (see also Issue 41).

In the simulated boxes, the FSC personnel were able to input actual fire missions into CBS through the TACFIRE system. These missions were assessed in CBS, with feedback provided to the response cells. (GRWSIM permits calls for fire but does not employ TACFIRE.) Fire support is a functional area in which simulation appears to be able to improve the quality of training.

Recommendation: We recommend continued development of simulations with actual military equipment interfaces. The use of real tactical communications equipment, such as TACFIRE, as the interface to a simulation has tremendous future advantage. The ability to train in a simulation on the types of equipment one uses in the field is a distinct advantage. Just as AWSIM has an advantage by using the EIFEL emulator terminals, CBS has an advantage by using Army tactical communications devices that interface directly with the simulation. Any new military equipment developments should be designed with a simulation option as part of their design requirements. For example, the lead author operated a U.S. Navy combat control terminal that had a built-in wargame mode to train personnel in a competitive environment. In the long run, a simulation mode designed into new equipment will reduce the requirements for specialized equipment for supporting exercises.

Issue 38: The counterbattery representation needs to be improved across all training modes.

Discussion: The representation of counterbattery (CB) fire in each training mode is still very limited. In live exercises, it is difficult to detect enemy firing locations since no shells are being fired and no CB radars are being employed. In simulations, the detection of artillery firing positions tends to be independent of any counterbattery detection systems or procedures. As a result, CB is not being adequately represented for training in any training mode.

Part of the difficulty in representing the employment of CB assets in a training mode is that the interactions and procedures associated with these assets far exceed the simple presence of the assets themselves. In reality, a radar is fairly easily detected if radiating

continuously. Therefore, the radar tends to transmit over short intervals. Similarly, tubes and launchers "shoot and scoot" to avoid receiving counterbattery fires. Therefore, the representation of actual CB assets and procedures is much closer to a "hide and seek" game between opposing assets. As a result, it is difficult to represent these interactions either in CFX/FTX or in simulations.

Recommendation: The development of good CB training procedures is an important issue. Since it is difficult to assess in the field, it is likely that any breakthroughs will be in the area of simulation. Since existing simulations do not represent counterbattery fires very well, priority should be placed on development in this functional area. The cost of this option is likely to be high, and will vary with the level of resolution of the simulation and its ability to adapt to new requirements.

Issue 39: Artillery should be constrained by ammunition supply, but this does not occur in the CFX/FTX nor often in the simulations.

Discussion: Artillery fire rates toward the end of the exercise were just as high as at the beginning of the exercise, in both the live and simulated boxes and for both threat and friendly forces. One reason that both sides were unconstrained in GRWSIM was that an insufficient number of personnel were available to handle logistics.

Recommendation: Investigate the options available in an exercise to constrain live and simulated artillery missions. If the only thing precluding realistic artillery ammunition consumption in the simulations is a shortage of training support personnel, then raise the priority of training support personnel to handle artillery ammunition consumption. The final report will discuss in depth the difficult tradeoffs between training combat element objectives and logistics training objectives.

COMBINED ARMS

Issue 40: Light infantry is not well trained when employed in good tank country.

Discussion: The exercise scenario was located in good tank country, where light infantry, even performing at peak levels, does not do well against an armored opponent. During this exercise, even when one brigade was infiltrated into the enemy's rear, it was identified and monitored by the opposing side. Although in rough terrain, it was surrounded by good tank country covered by mobile enemy forces.

In such situations, light infantry fighters are unable to receive the positive reinforcement that comes from successfully carrying out a mission. If the unit is aware of this, there is a risk of losing the motivation to perform.

Recommendation: When employing light infantry in training exercises, select exercise scenarios, terrain, and missions appropriate for their use. There is no additional cost involved in implementing this recommendation.

Issue 41: The benefits of deep reconnaissance and targeting are not well measured in current CFX/FTX exercises.

Discussion: When small light infantry forces or LRSUs penetrated deep into enemy territory and located and targeted enemy forces such as headquarters, convoys, or supply points, the fires against those targets could not be properly assessed because of a lack of umpires in the rear areas. A parallel problem existed for Spetsnaz action in the friendly rear area. Given the doctrinal[14] and tactical[15] importance of deep reconnaissance, it is important to attend to it in exercises.

Recommendation: Again, this is an important problem without an easy solution. It would be a poor idea to send umpires with each light infantry or LRSU unit, since the umpire would increase the risk of the infiltrating force being detected. Similarly, having umpires at potential targets would increase *their* risk of detection. Increasing the number of umpires to blanket the rear areas is prohibitively expensive. In time, one might have simulations that more easily permit linking FTX/CFX deep activity to simulated indirect fires, but this is both expensive and in the future. Perhaps a small mobile umpire cell that can be called by exercise control to examine and rapidly adjudicate deep activity is possible, especially if the cell could be informed by the light infantry unit of likely target locations before the assessment is required. No increased costs are estimated if umpires are provided a list of likely target locations in specified time periods. As another alternative, one could train selected light infantry or LRSU personnel in umpire techniques. This option might attempt to force "objectivity" on an inherently "partisan" person if selected from a unit in the training audience. However, if the selected umpire came from a different unit or even from the light infantry "school," a more objective umpire might be obtained. This option involves increased temporary duty (TDY) costs to obtain selected umpires with light infantry training from units not in the training audience.

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[14]See, for example, U.S. Army Field Manual FM 71-100, *Division Operations*, October 1989.

[15]M. Goldsmith and J. Hodges, *Applying the National Training Center Experience: Tactical Reconnaissance*, RAND, N-2628-A, October 1987.

ENGINEERS

Issue 42: The representation of minefields on hex-based terrain creates major artificialities in the simulations.

Discussion: In the simulations, scatterable mines delivered by air or artillery are generally represented as covering a 3000 meter hex. However, most minefields, scatterable or otherwise, cover only 400 meters. Therefore, modification to the simulation algorithms will improve the realism of scatterable mines.

Recommendation: It may be better to represent scatterable mines delivered by air or artillery as lying along hex sides, the same way all other minefields are presented in the simulations. This could help preclude unrealistically large minefields from appearing. The cost of a software change of this magnitude is small for the simulations used in CS 90.

SIGNAL

Issue 43: A CFX appears to be adequate for training the basic signal functional area tasks.

Discussion: Signal units appear to receive almost as much training from a CFX as they do from an FTX. The reason is that they are required to set up about as much communications in a CFX as in an FTX. Requiring the headquarters to move periodically provides sufficient stress on the signal units. In addition, CBS requires the standard Army tactical communications links between headquarters as does a CFX.

Recommendation: When assessing the benefits of CFXs, consider their demonstrated value for signal units.

CSS

Issue 44: The live corps CSS activities focused on maintaining the exercise rather than supporting the training of the CSS activities.

Discussion: 80 percent of the CSS activities during the exercise involved getting actual fuel and food to real vehicles and live personnel in the field. Only 20 percent of the CSS activities involved supporting the simulated activities (such as supporting a CFX unit or the computer simulated units). There was no personnel cell played at the WPC. Similarly, CBS had the Military Occupational Specialty (MOS) switch turned off, so only quantities of personnel, rather than their skill qualifications, were known. There appeared to be no concern about the electronic requirements or assets at the corps support commands (COSCOMs), since tracking simulated assets was considered very confusing (requiring separate bookkeeping of simulated and live assets), and there was no link between the

simulations and the COSCOMs. The biggest concern voiced at the corps rear was that a real fuel truck might be diverted to a simulated unit.

Recommendation: Corps-level exercises need to better engage the G1, G4, and G5 staff sections. This is an Army-wide problem that surfaces whenever higher-echelon exercises are conducted. Its accomplishment is beyond the scope of this Note, but it will be discussed in detail in the final report.

Issue 45: CSS constraints need to be able to restrict the activities of combat and combat support units in the exercise.

Discussion: During CS 90, there were many cases of virtually unrestricted activities by both live and simulated units regardless of realistic logistics constraints. Of particular concern were the ammunition flow to artillery units and construction consumables for engineer units. Neither side appeared to be constrained in POL, ammunition, or personnel in GRWSIM this exercise. Both Red and Blue were supposed to be equally constrained, but Red was not sufficiently manned to play full logistics. Since Red was not constrained, Blue became unconstrained as well. As was the case in CG 89, support units were tapped directly for replacement assets (Class VII—major end items—including tanks and artillery tubes), so that, for example, units were replenished at an unrealistic rate.

Recommendation: Investigate opportunities to impose CSS constraints to restrict CFX/FTX unit activities. Other CFX/FTX CSS representation options include coupon books (with associated rules to preclude transporting 30 tons of ammunition in one's pocket). In addition, the simulated CSS assets of each side need to be monitored to ensure that unrealistic resupply and reconstitution are not taking place. Finally, the results of successful attacks on resupply facilities, assets and operations need to be adequately reflected.[16]

Issue 46: Consumption rates in the models may exceed FM 101-10-1 and FM 101-10-2 planning factors.

Discussion: Both GRWSIM and CBS consumption rates were greater than the doctrinal rates published in FM 101-10-1 and FM 101-10-2.[17] Because neither the simulations nor the doctrine have been tested in real combat, it is unknown whether the models, the doctrine, or neither are correct. An almost universal experience of training audiences in GRWSIM- and CBS-run exercises is that the pace of warfare is greater than anticipated. Although war memoirs have often reported that the pace of war was higher

[16]See also Issues 39 and 42.

[17]See Issue 34 for a similar problem with regard to close combat attrition rates.

than anticipated, the question arises: How much higher would be a reasonable representation of a pace of war not yet fought?

Recommendation: The consumption rates in GRWSIM and CBS, as well as those behind the Army's doctrinal planning factors, should be carefully analyzed. Unfortunately, this comparison suffers from the same difficulty as comparing close combat outcomes between the models, as described in Issue 34.

AIRBORNE/AIR ASSAULT

Issue 47 (*): The representation of air assault operations was realistic.

Discussion: In CS 90, the air assault units had to be planned and actually fly to their target zones.[18] This was realistic in terms of limiting the ability to insert air assault forces as a threat to the rear area. However, many of the ingressing helicopters were assessed as being lost during the operation, primarily due to lack of JSEAD (see Issue 23). Therefore, these realistic limitations also created a problem for the controllers in presenting each corps with a significant rear threat. Without the ability to create a significant rear threat, the rear operations were not sufficiently exercised (see Issue 36).

Recommendation: Any attempt to both present a continuous rear area threat and use a reasonable air assault insertion technique will create artificialities, as those objectives have conflicting constraints. The solution lies in some combination of control-assisted insertion. For example, if two companies of threat forces are supposed to be inserted and only two platoons actually land, the controllers might assess that four companies attempted to land and only one company actually landed. This would present a sufficient threat to the rear area and still assess reasonable losses to the ingressing force. The specifics of how such actions will be assessed must be determined by priorities based on the relative importance of different training objectives set before the exercise begins. There is no increased cost involved in implementing this option. (See Issue 36.)

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[18]In CG 89 and earlier exercises, air assault units were transported via magic move.

IV. CONCLUSIONS

CS 90 represented a significant improvement in exercise planning and conduct over CG 89, in spite of the short interval between the two exercises. It is hoped that the recommendations in this Note will result in similar improvements in future exercises.

FIVE CATEGORIES OF ISSUES REQUIRING ATTENTION

It was not unexpected that a new set of issues would be raised as a result of the CS 90 exercise. Although all of the issues listed in the previous two sections are important, the most significant can be summarized in five categories:

Exercise Design: The mixed-mode exercise design in CS 90 did not provide a completely "seamless battlefield." The two overlapping GRWSIM games should not be used in the future since it led to significant confusion among players and controllers. The separate brigades within the CBS "box" operated relatively independently and were not well integrated into the corps battle. The simulated and live parts of the battle were often handled differently by the players if they anticipated confusion.

In our view, the prospects of providing a seamless battlefield in the near future are not promising. To the extent that seamlessness is a requirement for multi-echelon, mixed-mode exercises, the Army should reconsider the utility of such activities. As we discussed earlier, this topic will be discussed in detail in the final report.

Exercise Manning: Simulated headquarters need to be sufficiently manned to provide realistic human contact with exercised staffs. Actual unit staffs perform better in exercises than ad hoc staffs assembled for an exercise. Preparation and training of support augmentees need to be improved.

The direct implication of this point is that future exercises modelled along the lines of CS 90 are going to be costly, both in human and dollar resources. The additional cost means that the objectives of the exercise must be carefully spelled out, the design must be tight, and the value gained from the expenditures must be clear.

Scenario-Related Issues: The employment of an adjacent simulated corps in GRWSIM did not demand sufficient attention from the training audience. If simulated units are employed on the flanks, they should be made more salient to the activities of the training audience. In addition, the force ratios employed in the scenarios should more closely match Blue and Red doctrine. For example, attacks are not usually launched at a 1:1 force ratio. The continuous transition weekend was awkward and unrealistic. If the continuous weekend

transition is employed, it should be in conjunction with a smaller CFX/FTX force. If the exercise is going to function 24-hours-a-day, the simulation support should be available 24-hours-a-day.

Each of the issues mentioned here argues for a tighter exercise design, more focused on the objectives of the primary training audience, perhaps at the cost of neglecting some ancillary desires coming from higher headquarters. In a complicated activity such as a higher-echelon, multi-echelon, multi-mode exercise, any gain in simplicity that does not compromise the basic functioning of the primary training audience is welcome.

Threat Representation: The representation of the threat versus Blue forces needs to be more balanced. Red forces in GRWSIM need to be allowed to receive the same benefits of the defense posture as the Blue forces. In the same model, Blue attack helicopter capabilities need to be much more realistic. In addition, the unit resolution should be appropriate for the scenarios being represented. The threat to the deep and rear operations cells needs to be more continuous over time and synchronized with threat close operations. A way needs to be found to permit CBS to fight a Blue-on-Blue exercise without the confusing work-arounds that CS 90 required.

These issues are primarily addressed to the community of combat modelers. The next version of current models and the next generation of models should have these corrections incorporated into their design.

Simulation Calibration: The close operations and supply consumption representations in each simulation need to be compared with each other and with the standard U.S. Army planning factors in FM 101-10-1 and FM 101-10-2. This is especially true of combat attrition rates and artillery consumption rates.

These issues are primarily addressed to both the modelling and doctrinal communities. It is impossible, based on existing evidence, to know whether the current models, the doctrinal planning factors, or both are in error. The consequences of doctrinal error, either in the direction of the models' estimates or in the opposite direction, are severe for Army readiness and efficient budgeting.

A FINAL OVERALL GLANCE AT THE CS 90 EXPERIMENT

The tradeoffs between changes in training benefit and training costs are still not well understood when simulations are employed either in place of or in support of field exercises. Preliminary results indicate that the quality of training in several functional areas (e.g., intelligence for the deep battle) is improved through the use of simulations, but this is preliminary, very qualitative, and difficult to measure. Similarly, there are reduced

operational and maneuver damage costs but increased costs of simulation support, especially in communications costs to run large simulations distributed to remote sites in the field. Although cost data are much more quantitative, data are less available due to the number of financial sources that are involved in funding a large field exercise. This document has discussed only broad, relative costs (such as high, medium, or low); the final report will discuss more detailed costs for consumables, maneuver damage, and communications.

This Note does not attempt to address whether the use of mixed modes of training in a single exercise is desirable. There are a number of potential benefits as well as a number of tangible artificialities that occur in exercises that employ more than one training mode. Whether the benefits of mixed-mode training exercises outweigh the costs and complications is a subject reserved for the project's final report in which the issues can be addressed in more detail.

In a similar manner, the authors address neither the desirability nor the costs of employing more than one ground combat simulation in a single exercise. Overall, this Note is intended to provide supporting material for the project; predictions about the future of simulation support of large-scale field exercises are reserved for the final report.

Appendix A
CENTURION SHIELD 90 DATA COLLECTION PLAN FORMAT

PURPOSE AND BACKGROUND:

Appendix A presents the data collection plan originally used for the CS 90 exercise. This data collection plan is included to document the categories of data examined and the procedures involved in collecting the data. Since the appendix presents the data collection plan as employed in this exercise, it is written in the future tense.[1]

This data collection plan could be of use to anyone performing a similar analysis of future training exercises.

THE DATA COLLECTION PLAN FOR CS 90:

Prior to CG 89, we found it useful to prepare a data collection plan to coordinate observation activities. A similar data collection plan was prepared for CS 90. The format is similar to the plan used for the CG 89 exercise but was expanded to account for the difference in focus during the CS 90 exercise.

For example, during the CG 89 exercise, there was little interaction planned between the different simulations or with the field exercises. During the CS 90 exercise, more interactions are planned, and contingencies for possible but unplanned interactions between these training modes are prepared. These contingencies are listed in the Rules of Engagement (ROE) document prepared by Major Tom Hill (see App. B). These planned and contingency interactions have been reflected in this revised data collection plan.

In addition, Colonel Charlton and Major Hill defined five areas RAND should investigate more thoroughly, in addition to covering the basics of each of the functional areas as in the CG 89 exercise. The five functional areas of focus are:

- Maneuver
- Air and ADA
- Fire support (non-air)
- Intelligence
- Deep battle

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[1]Please see Glossary of Acronyms, page xxi, for any abbreviations in this appendix.

At least three simulations will be used to support the exercise: GRWSIM, AWSIM, and CBS. (Other WPC models include the EW model and other functional area-specific models.) GRWSIM is the WPC ground model; AWSIM is the WPC air model.

Another difference between CG 89 and CS 90 is that CG 89 had a rather balanced mix of FTX and CFX units employed in the exercise. (FTX units use all of the unit's assets, whereas CFX units use only the command vehicles. Therefore, a tank platoon is represented by a single tank in a CFX.) For the CS 90 exercise, however, most of the units will be CFX units. A few light infantry units will be FTX units, but no tanks will be maneuvering in the field.

GENERAL DATA ITEMS TO COLLECT IN EACH AREA:

- Time label for each data item listed above
- Interface problems
- Realism, as measured by subjective inputs from observers and players.

Collection Plan: All data items mentioned below and on separate data requirements sheet should be time stamped.

Collection Frequency: Determined by the type and source of data collected, the issue being addressed, and the accessibility of the collector to the data.

Data Format: Handwritten notes are usually acceptable, including time of interview, who interviewed, position in the exercise (e.g., player, controller), and comments.

Points of contact (POCs): Personnel assigned to collect specific data items at specific locations.

HARDWARE AND COMMUNICATION LINKS ISSUES:

A primary area of concern is whether each training mode provided the basic level of support, as defined by simulation and communications link uptime. Since this area is relatively easily measured, it is described first.

How often do the simulations and interfaces function during the exercise? A good basic measure of effectiveness is the fraction of the time the systems are up and functioning.

WPC uptime:

CBS uptime:

WPC/CBS satellite link uptime:

CFX updates to CBS:

CBS updates to GRWSIM:

FUNCTIONAL AREA REPRESENTATION AND INTERFACES

How well do the simulations and interfaces function? Are there other difficulties in information transfer? What do they need to do better next time?

Interfaces will be measured with respect to the following functional areas:

- Time resolution
- Terrain resolution
- Unit resolution (and passing information back and forth)
- C2
- Air (area of focus)
- Air defense (area of focus)
- JSEAD
- Intelligence (area of focus)
- EW
- Threat play
- Corps picture
- Deception
- Deep battle (area of focus)
- Rear battle
- Fire support (non-air) (area of focus)
- Attrition rates
- Maneuver (area of focus)
- Combined arms
- Engineers
- CSS
- Airborne/air assault
- SOF/LRSU/Spetsnaz

Time resolution

WPC time resolution: assessed every 20 minutes.

CBS time resolution: an event-stepped model.

WPC/CBS interface updates: exchanged every 30 minutes.

CFX unit location updates to CBS and WPC: every 4 hours.

Look for situations in which the differences in time resolutions may create problems when passing information between the two models. For example, the representation of

intelligence collection and reporting may be affected by the differences in time resolution between the models.

Terrain resolution

3.2 km hexes are used at WPC, whereas 3.0 km hexes are used in CBS. Although passed by UTM coordinates, coordinates tend to be passed from center of hex to center of hex for WPC, and by center of hex plus offset in CBS. Does this difference create any problems?

For example, units in the WPC model are always at the center of the hex, whereas units in CBS may be offset from the center of the hex. How are the unit locations passed between models? Are the UTM coordinates defined from the center of the unit or the center of the hex?

Are there any problems with the differences in the terrain representation that affect the actual unit operation? For example, barriers such as river lines are always traced along hex edges in both models. When the actual river lines do not trace along a hex edge, the barrier must be "moved" until it lies on a hex edge. As a result, the difference in hex sizes between the two models may lead to a unit at the same UTM coordinates lying on opposite sides of the river in each simulation. This will tend to create problems only when the two models interact with each other.

Unit resolution (and passing unit information back and forth)

Examine the frequency and accuracy of unit information transfer and record problems encountered.

CFX updates to CBS:

CBS updates to WPC:

WPC updates to CBS:

C2

SIMULATED CHAIN OF COMMAND:

Interfaces: Liaison officers and scout platoons on flanks, higher and lateral headquarters for the exercise, and who reports to whom must all be well coordinated before the start of the exercise. Who talks to whom? What is the simulated command relationship? Does this command relationship cross training modes?

Collection Plan: Attempt to record the picture presented to the commander at division and corps level at predetermined times (to be determined). The "seamless" picture is the measure of effectiveness for multiple training modes.

Collection Frequency: At least every 6 hours (see intelligence functional areas below).

Data Format: Handwritten notes are usually acceptable, including time of interview, who interviewed, position in the exercise (e.g., player, controller), and comments.

Points of Contact (POCs): To be determined (TBD).

AUTOMATED C2 IN THE SIMULATIONS:

GRWSIM: very limited, such as unit thresholds to break off contact with the enemy.

CBS: very limited as well.

Interfaces: When unit information is passed between models, does this information include the unit's current mission? Supply relationship? Fire support relationship?

Collection Plan: Attempt to monitor the unit data being passed between simulations to determine whether sufficient C2-related data are being passed.

Collection Frequency: At least every 6 hours (see intelligence functional areas below).

Data Format: Handwritten notes are usually acceptable.

POCs: TBD

Air (One area of focus)

Fixed wing—flying against real vs. imaginary targets

Rotary wing—flying in exercise vs. in simulations

WPC: Emphasis in REFORGER on deep air (AI, OCA, deep BAI), some CAS and shallow BAI played on flanks.

CBS: Emphasis in REFORGER on CAS and helicopter.

CFX: Emphasis in REFORGER on air-ground coordination procedures, especially helicopter, CAS, reconnaissance, and BAI.

WPC-to-CBS: No GRWSIM aircraft will appear in CBS.

WPC-to-CFX: Generally, no damage to real ground forces by simulated aircraft to be played. However, contingencies have been prepared to allow aircraft to damage CFX units on the ground (see ROE).

CBS-to-WPC: No CBS aircraft will appear in GRWSIM.

CBS-to-CFX: Generally, no CBS aircraft will appear in CFX. Contingencies have been prepared for air attacks damaging ground units (see ROE).

CFX-to-WPC: Generally, no actual aircraft will affect the GRWSIM model. However, contingencies for such assessment exist (see ROE).

CFX-to-CBS: Generally, no actual aircraft will affect CBS. Contingencies exist (see ROE).

Collection Plan: Number of aircraft (fixed and rotary wing) flown in each training mode and any effects of air missions that cross any of the interfaces. *Focus particular attention on air/ground coordination, including procedures and potential problems associated with artificialities encountered within and between training modes.*

Collection Frequency: Number of aircraft flown (and where flown) in each training mode should be recorded for later comparison. See Specific Data Collection Requests sheet. Air effects on ground units across interfaces collected "by exception." Whenever any type of aircraft (actual or simulated) has an effect on a different training mode (across an interface), record event. Since this is anticipated to be a rare event assessed under special conditions, record by exception.

Data Format: Air effects on ground units: Hardcopy. Handwritten notes ok. Time, location, from training mode, to training mode, effects.

POCs: TBD

Air Defense (One area of focus)

GRWSIM: HIMAD representation planned for area of operations; SHORAD planned for flank operations.

CBS: SHORAD representation planned for this exercise.

CFX: Representation difficult unless actual aircraft are flown for training of SHORAD personnel.

GRWSIM-to-CBS: No GRWSIM ADA will affect CBS. However, CBS aircraft are assumed to be flying too low and shallow to be affected by GRWSIM HIMAD. Periodically monitor CBS air activity to ensure assumptions not violated.

GRWSIM-to-CFX: No GRWSIM ADA will affect aircraft actually flown.

CBS-to-GRWSIM: No CBS SHORAD will affect GRWSIM flown. However, CBS SHORAD units will be duplicated in GRWSIM so that a SHORAD threat exists in GRWSIM over the CBS box. This helps keep a realistic SHORAD threat against penetrating aircraft in GRWSIM.

CBS-to-CFX: No CBS ADA will affect the CFX.

CFX-to-GRWSIM: Actual ADA will not affect GRWSIM.

CFX-to-CBS: Actual ADA will not affect CBS.

Collection Plan: Number of AD engagements and outcomes in each training mode and any effects that cross interfaces (none anticipated). *Focus of attention will be on problems interfacing the representation of ADA between the CBS and GRWSIM models.* There does not appear to be an interface between live and simulated ADA.

Collection Frequency: See Specific Data Collection Requests sheet for AD activity within a training mode. Any effects across interfaces collected by exception.

Data Format: Interactions across interfaces may be handwritten, including time, location, from training mode, to training mode, effects (if known).

POCs: TBD

JSEAD

GRWSIM: JSEAD activity for this exercise planned only for the simulations (primarily AWSIM) and will be accomplished by control intervention reducing all HIMAD (and possibly SHORAD) effectiveness for a specified period of time.

CBS: No JSEAD activity planned for this exercise, since only non-radar SHORAD assets being represented in CBS this exercise.

CFX: None planned.

GRWSIM-to-CBS: No GRWSIM JSEAD operations will affect CBS. SHORAD assets in the CBS box duplicated in the GRWSIM box will be suppressed in the same manner as other GRWSIM SHORAD assets.

GRWSIM-to-CFX: No GRWSIM JSEAD operations will affect the CFX.

CBS-to-GRWSIM: No CBS JSEAD operations will affect GRWSIM.

CBS-to-CFX: No CBS JSEAD operations will affect the CFX.

CFX-to-GRWSIM: No CFX JSEAD operations will affect GRWSIM model.

CFX-to-CBS: No CFX JSEAD operations will affect CBS model.

Collection Plan: By exception only. Monitor any JSEAD operation mounted from GRWSIM and determine whether any simulated effects need to be passed to CBS or CFX. *Focus is on the ability to reflect JSEAD operations in this manner at WPC and possible disconnects with other training modes.*

Collection Frequency: On a "by exception" basis.

Data Format: Handwritten notes ok, including time, location, from training mode, to training mode, effects (if known).

POCs: TBD

INTEL (One area of focus)

GRWSIM: The GRWSIM Intelligence Collection Model (ICM) will be used to create the most complete picture of ground truth.

CBS: CBS will use data from GRWSIM ICM model.

CFX: Will fly real-world assets for collecting against real Blue assets.

GRWSIM-to-CBS: Intelligence data will not be passed directly from GRWSIM to CBS, but through the intelligence staffs participating in the exercise.

GRWSIM-to-CFX: Intelligence data will be passed to CFX through the intelligence staffs participating in the exercise. Intelligence staffs will be passed the data electronically by terminal, or by hardcopy if terminal not available.

CBS-to-GRWSIM: No intelligence data will be passed. Ground truth of unit IDs and locations will be automatically passed to GRWSIM on a regular basis (every 30 minutes).

CBS-to-CFX: No intelligence data will be passed directly to CFX.

CFX-to-GRWSIM: Only ground truth (not intelligence reports) of unit IDs and locations (not unit strengths) will be passed from CFX to CBS to GRWSIM via umpire reports.

CFX-to-CBS: Only ground truth (not intelligence reports) of unit IDs and locations (not unit strengths) will be passed from CFX to CBS via umpire reports.

Collection Plan: Monitor the intelligence picture from both Blue and Red perspectives and from each corps at prespecified times. *Focus on the potential disconnects in timing and quality of data passed between training modes.*

Collection Frequency: At least every 6 hours for corps deep battle cell, for a "snapshot" of Blue's perception of Red and Red's perception of Blue in GRWSIM and CBS. Monitor corps staff intelligence picture on an "as available" basis.

Data Format: Sketch maps from corps deep battle cell, standard GRWSIM output file for intelligence module, similar CBS output file for "picture" of battlefield.

POCs: TBD

EW (Including SIGINT/ELINT, and countermeasures)

GRWSIM: Manual EW play will be performed in support of JSEAD operations. Implemented through model control.

CBS: None planned.

CFX: None planned.

Interfaces: None planned.

Collection Plan: Any manual interventions to make EW effects work in this exercise. See ADA functional area above.

Collection Frequency: NA.

Data Format: NA.

POCs: None required.

Threat Play

GRWSIM: Red front, Army, and division commanders facing each U.S. V and VII Corps headquarters.

CBS: Opposing Blue players (brigade level), but one side will be labelled "Gold" (since one side must be other than Blue in CBS).

CFX: Blue on Blue

Interfaces: None planned.

Collection Plan: Look for problems in the simulated threat chain of command, the use of proper Red doctrine where applicable, and the play of Blue and Red opponents.

Collection Frequency: Every two to four hours.

Data Format: Handwritten notes OK.

POCs: TBD

Corps Picture

Collection Plan: Observe the corps picture presented to each corps HQs. Determine if it is "seamless" and draws attention to the flanks and deep battle (as opposed to just the CFX).

Collection Frequency: As available.

Data Format: Sketch maps and handwritten notes are fine.

Deception

No play of deception currently planned in the simulations (not known if planned for the CFX).

Deep Battle (One area of focus)

Collection Plan: Observe the deep battle cells if possible. Determine if the data quantity, quality, frequency, and format are sufficient to meet the deep battle cell's needs. *Focus is on whether a consistent and realistic picture is being presented to each corps deep battle cell.* Sample questions include: Is the timing of Red unit movements reasonable? Is there sufficient information to prepare useful NAIs and TAIs? Is there too much

information? Is the information of the right type (e.g., raw data for the intelligence analysts to prepare as opposed to fused data)?

Collection Frequency: As available.

Data Format: Sketch maps and handwritten notes are fine.

Rear Battle

Collection Plan: Observe the rear area combat operations cells if possible. Determine if the data quantity, quality, frequency, and format are sufficient to meet the rear battle cell's needs. *Focus is on whether a consistent and realistic picture is being presented to each corps rear battle cell.* Sample questions include: Are the airborne/airmobile threats in the rear areas reasonable? Is there sufficient information provided to predict and prepare responses to these threats? Is there too much information? Is the information of the right type?

Collection Frequency: As available.

Data Format: Sketch maps and handwritten notes are fine.

Fire Support (non-air) (One area of focus)

GRWSIM-to-CBS: No GRWSIM artillery fires are planned to interact with CBS.

GRWSIM-to-CFX: Generally, no damage to real ground forces by simulated artillery will be played. However, contingencies exist for this type of interface (see ROE).

CBS-to-GRWSIM: No CBS artillery fires are planned to interact with GRWSIM.

CBS-to-CFX: Generally, no CBS artillery fires will affect CFX. Contingencies exist for this interaction (see ROE).

CFX-to-GRWSIM: Generally, no CFX artillery fires are planned to affect GRWSIM. However, contingencies for this type of interaction exist (see ROE).

CFX-to-CBS: Generally, no CFX artillery fires will affect CBS. However, contingencies for this type of interaction exist (see ROE).

Collection Plan: In addition to attrition data (see below), any fire support actions that cross the interfaces should be recorded. *Focus is on the performance of these interfaces when they are employed.* Data requirements include the time from planning the mission to assessing and recording/reporting results to affected training mode, apparent realism, and possible gaps in data between training modes (e.g., CFX unit was dug in, but simulation assessed as though in the open).

Collection Frequency: See Specific Data Collection Requests sheet for data within each training mode. Events that cross interfaces done by exception.

Data Format: For "by exception" data, handwritten notes are ok, including time, location, from training mode, to training mode, and effects.

POCs: TBD

Attrition Rates

GRWSIM: See Specific Data Collection Requests sheet (not included in appendix).

CBS: See Specific Data Collection Requests sheet.

CFX: To be determined after the fact from umpire reports.

GRWSIM-to-CBS: No GRWSIM attrition will affect CBS forces.

GRWSIM-to-CFX: GRWSIM loss rates might affect selected forces on the ground by fire support attacks, but not by direct fire (see fire support and maneuver functional areas).

CBS-to-GRWSIM: No CBS attrition will affect GRWSIM forces. If a CBS unit is destroyed or merges with another unit, this fact will have to be recorded manually in GRWSIM.

CBS-to-CFX: No CBS attrition will affect the CFX, unless contingency ROE plans employed (see fire support and maneuver functional areas).

CFX-to-GRWSIM: CFX losses will not be seen by GRWSIM until unit is destroyed or merged. See fire support and maneuver functional areas for additional details.

CFX-to-CBS: CFX losses will not be seen by GRWSIM until unit is destroyed or merged. See fire support and maneuver functional areas for additional details.

Collection Plan: See separate sheet on Specific Data Collection Requests. Focus is on differences in attrition rates between training modes.

Collection Frequency: See separate sheet on Specific Data Collection Requests. In addition, any attrition data passed across an interface (e.g., unit destroyed) recorded on a "by exception" basis.

Data Format: Events that cross interfaces may be handwritten, including time, location, from training mode, to training mode, and effects.

POCs: TBD

Maneuver (One area of focus)

GRWSIM-to-CBS: No GRWSIM forces will appear in CBS while they are controlled by GRWSIM. Control of units may be passed between CBS and GRWSIM, and vice versa.

GRWSIM-to-CFX: Generally, no GRWSIM forces will appear in the CFX. However, contingencies exist to assess the combat results of simulated and CFX units (see ROE).

CBS-to-GRWSIM: No CBS forces will appear in GRWSIM while controlled by CBS. Control of units may be passed between CBS and GRWSIM, and vice versa.

CBS-to-CFX: Generally, no CBS forces will appear in CFX. However, contingencies exist to assess the combat results of simulated and CFX units (see ROE).

CFX-to-GRWSIM: CFX FLOT will drive the GRWSIM FLOT at the interface. Interface between live and simulated units addressed above. There is not potential for an exposed flank between GRWSIM and CFX since there is no left flank to the U.S. VII Corps (or right flank to U.S. V Corps). It is assumed to be impassible terrain.

CFX-to-CBS: CFX FLOT will drive the CBS FLOT at the interface. Interface between live and simulated units addressed above. Note that current plans assume that an exposed flank between CBS and CFX will allow for airmobile and other rotary wing assets to penetrate across the exposed flank.

Collection Plan: Any forces that cross the interface should be recorded (ID, time, place). *Focus is on the interfaces between training modes on the flanks.* Monitor the interaction of real and simulated units on "by exception" basis to determine whether the representation is satisfactory. Specific data items include: the time from planning the mission to assessing and recording/reporting results to affected training mode, apparent realism, and possible gaps in data between training modes (e.g., the unit being attacked was actually hit on the flank as opposed to head-on).

Collection Frequency: Whenever units cross from one box to another, collected on a "by exception" basis.

Data Format: Handwritten notes ok, including time, location, from training mode, to training mode, and purpose of maneuver (if known).

POCs: TBD

Special data item: Observe how the scout platoon interacts on the CFX/CBS flank.

Collection Plan: Umpire reports after the exercise.

Commitment of reserves on each side: Reserve forces may cross the interfaces during this exercise. This is accomplished most easily in the simulations. However, reserve simulated forces may be played in the CFX box. This is also planned for the weekend play,

allowing the simulation to continue while the CFX rearranges forces for the second week of the exercise.

Combined Arms

GRWSIM: No light infantry in data base this exercise.

CBS: No light infantry in data base this exercise.

CFX: Some light infantry units this exercise. Just how they will interact with CFX-type units needs to be determined after exercise based upon umpire reports.

Collection Plan: Monitor interactions between light units and other CFX units via umpire reports and "hot-wash" (after action) discussions.

Collection Frequency: As available.

Data Format: Handwritten notes OK.

POCs: TBD

Engineers

GRWSIM: Barriers will be played.

CBS: Barriers will be played.

CFX: Engineer tape used to simulate barriers.

Interfaces: None planned.

Collection Plan: Any manual interfaces to match engineer actions between training modes.

Collection Frequency: On a "by exception" basis whenever an interface is crossed.

Data Format: Handwritten notes ok, including time, location, from training mode, to training mode, and effects (if known).

POCs: TBD

CSS

GRWSIM: None planned for this exercise.

CBS: Selected features represented.

CFX: Ammunition "coupon books" will be provided to CFX participants to help restrict the flow of simulated ammunition.

Interfaces: None planned.

Collection Plan: Monitor the apparent consumption of supplies (particularly ammo and POL) in each training mode, and attempt to determine if there are massive differences in the apparent consumption rates. Any "returns to service" from maintenance or "filler" units need to be tracked in GRWSIM, CBS, and CFX. See Specific Data Collection Requests sheet.

Collection Frequency: See Specific Data Collection Requests sheet. In addition, attempt to obtain estimates of ammo and POL consumption over time in each training mode.

Data Format: See Specific Data Collection Requests sheet.

POCs: TBD

Airborne/Air Assault

Limited amount of airborne/air assault planned in this exercise to stress the corps staff. Observe as they are being planned and occur. Monitor any apparent discrepancies in doctrinal employment, assessment of insertion and loss rates, and combat assessment once on the ground. Handwritten notes are fine.

SOF/LRSU/Spetsnaz

GRWSIM: A small number of LRSU/Spetsnaz teams are to be employed strictly for reconnaissance purposes.

CBS: A small number of LRSU/Spetsnaz teams are to be employed strictly for reconnaissance purposes.

CFX: None planned this exercise, but light stay-behind operations possible.

Interfaces: None planned.

Collection Plan: No data to be collected in this area.

Collection Frequency: NA.

Data Format: NA.

POCs: None required.

Appendix B

RULES OF ENGAGEMENT AMONG TRAINING MODES FOR CS 90[1]

The following rules of engagement were prepared by Major Thomas Hill, Exercise Directorate, USAREUR, before the exercise in order to create as seamless a battlefield as possible across all of the training modes. A discussion at the end of this appendix addresses which areas appeared to be seamless during the exercise, and which did not.

1. PURPOSE. To outline the concept for the use of simulation, and the blend of live maneuver and simulation during CENTURION SHIELD 90.

2. GENERAL: CENTURION SHIELD will use a combination of live maneuver (FTX and CFX) with simulation-assisted CPX. The simulation will combine heterogeneous games (CBS and JWARS) through an automatic interface. CBS will be used to represent brigade and below units, particularly two separate armored brigade. JWARS, the combination of GRWSIM (Ground Warfare Simulation) and AWSIM (Air Warfare Simulation) models will be used to represent Division and above units at WPC. The training audience for this exercise is battalion through Corps battle staffs. This document will define the varied ways that simulation will be used to affect this training audience. It will use the eight operating systems as the outline for this discussion.

3. COMMAND and CONTROL:

a. CBS DISTRIBUTION. The distribution of CBS simulation during the exercise consists of six field simulation centers positioned throughout CBS corridor in the northern V and VII Corps portion of the maneuver area. Each center will have CBS simulation computer terminals for the companies of two separate armored brigades. Company/Battery/Troop Commanders will pass battle resolution data derived from the CBS computer terminals to their respective battalion headquarters via doctrinal communications means (doctrinal FM radio nets).

b. JWARS will be distributed from the Warrior Preparation Center (WPC) to six field locations: CENTAG HQ (RUF): the Exercise Control Center at Crailsheim; and a primary and alternate location for both V and VII Corps. Each of these distribution packages, or boxes, consists of various devices to interface with the WPC system and coordinate and control WPC simulation activities. The function of each of these devices will be discussed under the appropriate battle operating system.

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[1]The Rules of Engagement are reprinted here with the permission of Major Thomas Hill, Exercise Directorate, USAREUR.

c. A control team of one site chief and 5 civilian control technicians comes with each distributed simulation package to perform the following functions:

(1) Install the simulation terminals at the site.

(2) Establish commo with WPC.

(3) Operate the control interface between the site and WPC main frame.

(4) Advise and assist staff section in using the equipment.

d. Simulation control

(1) Simulation will be controlled at the ECC. This is the only place that all three exercise systems, live maneuver, CBS, and WPC, come together to show one complete picture of the exercise.

(2) CBS will be used to control and fight units within the CBS corridor brigade sized and smaller.

(3) JWARS will be used to control and fight division and higher formations.

(4) The ECC will provide technical control over all three exercise systems while CENTAG will provide the tactical control of the exercise. The primary technical and tactical coordination necessary to achieve the objectives of the exercise will be accomplished through the CENTAG LNO team and the Exercise control staff in the ECC.

(5) CENTAG will provide the tactical guidance to the live maneuver Corps and to the two Blue simulated Corps based on COMCENTAG/CINCUSAREUR's intent. This tactical maneuver guidance will be passed to the Exercise Control Staff in the ECC through the CENTAG LNO team. The CENTAG guidance will be unifying link between two corps WPC simulations.

(6) The Exercise Simulation Control Staff, specifically the Deputy Senior Controllers for Operations, Intelligence, and Logistics, will convert CENTAG's tactical guidance into the parameters necessary for the Red commanders at the WPC to accomplish CINCUSAREUR's training objectives.

(7) The functions of the ECC Simulation Control Staff are:

(a) Monitor the behavior of all three exercise systems (maneuver, CBS, and WPC) to insure that they remain synchronized in accomplishing the exercise training objectives.

(b) Advise the Exercise Director and Exercise Controller on courses of action that can be taken technically to accomplish the exercise training objectives or to synchronize the three exercise systems.

(c) Advise the CENTAG staff on the technical circumstances of the CENTAG tactical guidance.

(d) Convert CENTAG tactical Blue guidance into the orders necessary for the Red threat Commanders to accomplish the training objectives.

(e) Provide technical control for CBS distributed sites.

(f) Provide logistics control for CBS and off line control for WPC simulations.

(g) Fly air support simulations for Army Aviation and Air Force for the CBS Brigades.

(h) Input live maneuver unit names and locations into the simulated systems and update them at least every four hours. Live unit locations from the umpire control system of battalion center of mass will be inputted into the CBS System.

4. MANEUVER:

a. Live maneuver and simulated forces will not normally be brought into direct conflict. However, simulated forces can be used to threaten a live unit either directly or by exposing a flank.

b. Simulated forces may move through territory marked for live forces providing proper coordination is made with the friendly live headquarters and the simulated forces do not come into direct contact with enemy live forces.

c. Live forces may also move through the CBS corridor providing proper coordination is made with the CBS Brigade headquarters and the live unit does not come into direct contact with enemy simulated forces.

d. A simulated penetration on a live corps' flank can be used as a staging area for live Airmobile assaults into the exposed corps' rear area.

e. Although it is intended that live and simulated forces do not come into direct conflict, it could happen. In the event that it does happen the following rules will apply.

(1) The commander that intends to use either live or simulated forces against the other must make the intent known to the ECC four hours before the operation.

(2) The ECC will contact the UCC to have the necessary float umpires in position to adjudicate for the simulated unit.

(3) The ECC will input the live unit's relative combat power and position into the appropriate simulation.

(4) The ECC will pass the simulated unit's disposition and posture to the float umpires through the UCC and the appropriate ACC.

(5) The ECC will notify the appropriate simulated unit of the impending live attack.

(6) The float umpires for the simulated unit and live unit umpires contact each other by FM once they have moved into range to exchanged unit strength dispositions and postures.

(7) The conflict is fought in the simulation model and the battle outcome is transmitted to the umpires through the UCC and appropriate ACC.

(8) Battle resolution and casualties are assessed by the float and live umpires and appropriate stand-off distances are taken.

(9) If the battle is to be rejoined, then the procedure begins again.

5. INTELLIGENCE:

a. Corps intelligence collection assets and echelon above corps collection assets will be available in simulation.

b. Collection missions for corps Air Exploitation Battalion (AEB) assets will be tasked to both live and simulated units. That is, when a live mission is flown against live units, a mission is also flown in simulation against simulated units.

c. Corps simulated collection missions will be tasked to the WPC Intelligence Collection Model (ICM) directly by the Corps collection managers using the terminal provided by the WPC technical control team at the Corps TOC.

d. Collection mission results will output on the WPC high speed printer located in the Corps TOC.

e. Corps AEB collection missions will provide two reports; one from the live sensor downlink to show real time data on live units, and one from simulated missions passed over the rapid printer. Corps collection managers will meld the two reports to provide an integrated picture of the Battlefield.

f. Intelligence collection requests for real world EAC assets will go through normal channels and generate a concurrent mission in the simulations. The WPC Intelligence White Cell will

(1) receive the collection requests,

(2) task the intelligence collection model (ICM),

(3) place the mission results in the appropriate report format,

(4) pass the appropriate intelligence to the requesting unit through the appropriate intelligence channel.

g. The WPC Intelligence Cell will pass the reports of nationally collected information directly to the Corps using the communications terminal provided by the WPC simulation distribution package.

h. TAC RECCE missions will be tasked through the Corps ASOC.

(1) The ASOC will pass the mission using the WPC EIFEL Emulator.

(2) The simulated ATOC will cause the mission to be flown in the simulation and pass the mission results back to the ASOC through the TARRS communications network.

i. Intelligence communications terminals should be located in the Corps G-2 area and the EIFEL emulator should be located in the ASOC. However, if there is lack of space for these terminals, operators must go to the WPC control area to enter the requests and pick up mission results.

j. TRS intelligence collection requests will be passed through normal channels and TRS mission results, both live and simulated, will return to the requesting unit over real world

communications systems. Additionally, simulated TRS direct data input reports will be passed through the WPC simulation distribution package directly to the Corps.

6. FIRE SUPPORT:

The following describes the integration of live and simulated fire support for artillery, Army Aviation, CAS and BAI. No Air Interdiction campaign is planned for this exercise.

a. Artillery: Artillery will be able to fire between live forces and simulated forces. There will be an inherent time lag in passing the information between the two systems, however, the following procedures will apply:

(1) All simulated missions will be executed in the system in which it originates.

(2) Live to CBS.

(a) Fire support mission will be executed in CBS.

(b) Coordination for fire support between live units and CBS brigades will take place between the live unit FSE, Division and Corps, and the CBS brigade FSO.

(c) The live FSE must pass the FSO which unit is firing what simulated targets, the location of the live unit conducting the firing, a live unit strength.

(d) The CBS brigade FSO will call the CBS control cell at the ECC, have him update the live unit information in the CBS system, and pass the fire mission to be executed in simulation.

(e) The CBS controller will execute the fire missions in simulation.

(3) CBS to Live

(a) Fire support mission will be executed in CBS.

(b) Coordination for fire support between CBS brigades and live units will take place between the CBS brigade FSO and the live unit FSE.

(c) The CBS brigade FSO will call the CBS controller at the ECC and pass the fire missions to him.

(d) The CBS controller will execute the fire missions in simulation.

(e) The CBS controller will pass the fire missions results to the fire support cell at the UCC.

(f) The UCC fire support cell will pass the fire mission results to the ACC responsible for the target.

(g) The ACC will alert the umpire for the unit, or a fire marker, to adjudicate the fire mission results against the live unit.

(4) Live to WPC

(a) Fire support missions will be executed in GRWSIM (JWARS).

(b) The live unit FSE will contact the WPC controller at the Corps TOC and pass the fire mission.

(c) The WPC controller will execute the fire mission in simulation.

(5) WPC to Live

(a) Fire Support mission will be executed in GRWSIM (JWARS).

(b) The WPC unit FSE coordinates with the WPC controller at the ECC for a fire mission against a live unit.

(c) The WPC unit FSE executes the fire mission in simulation.

(d) The WPC controllers at the ECC receives the fire mission results over the control terminal.

(e) The WPC controller notifies the fires support cell in the UCC of the fire mission results.

(f) The UCC fire support cell forwards the mission results to the ACC responsible for the target.

(g) The ACC notifies the targeted unit umpire, or a fire marker, to adjudicate the fire mission results against the live unit.

b. Army Aviation: Army Aviation attack missions from live to simulated and simulated to live will be flown in the WPC model. All Army Aviation attack missions will be flown simultaneously live and in the simulations.

(1) Live to Simulation

(a) The targeting cell in the Corps TOC will notify the WPC controller at the TOC of the live attack mission against a simulated target and provide him with a copy of the plan.

(b) The WPC controller will fly the attack mission in the simulation in accordance with the Corps attack plan.

(c) The WPC controller will provide the Corps the results of the attack mission.

(2) Simulation to Live

(a) The WPC unit Aviation controller will notify the WPC controller at the ECC of an attack mission against a live target.

(b) The WPC unit aviation controller will fly the attack mission in simulation.

(c) The WPC controller at the ECC will receive the attack results over the WPC system.

(d) The WPC controller at the ECC will notify the UCC of the attack results.

(e) The UCC will notify the ACC responsible for the target of the attack results.

(f) The ACC will notify the umpires of the targeted unit to adjudicate the attack results against the targeted unit.

c. CAS: All live CAS will be flown against live targets. Simulated CAS can be flown against simulated and live targets.

(1) Corps ASOCs will allocate CAS sorties to be flown in simulation to the CBS brigades.

(2) CBS Air Controller will fly all CBS CAS sorties.

d. BAI: All live BAI will be flown against live targets. Simulated BAI can be flown against simulated and live targets. All BAI will be flown in WPC simulation.

(1) Corps ASOCs will coordinate all planned live targets with the 4ATAF LNO at the ECC. 4ATAF LNO will designate live targets to be flown.

(2) If the target is designated by 4ATAF LNO, the ASOC will pass the mission request to the live ATOC using the EIFEL system.

(3) If the target is simulated the ASOC will pass the mission request to the simulated ASOC at WPC using the EIFEL Emulator terminal at the Corps TOC.

(4) The Simulated ATOC at WPC will have the mission flown in simulation.

(5) Mission results from both live and simulated will pass to the ATOC LNO at CENTAG HQ. Over real EIFEL and EIFEL Emulation.

(6) The CENTAG ATOC LNO cell will combine both live and simulated mission results and pass these results to the appropriate Corps using the EIFEL Emulator.

7. AIR DEFENSE ARTILLERY:

a. ADA assets will be played in their respective simulations.

b. WPC ADA assets will be spread throughout the live and CBS overlays in order to portray ADA effects against WPC simulated rear battle and BAI missions.

(1) ADA positions will be portrayed in both Red and Blue games.

(2) Red ADA positions will be transposed to the Blue game to portray these effects.

c. JSEAD will be accomplished off-line by coordination between the Corps and the Simulation Control cell at the ECC.

(1) The Corps will pass the area to be affected by the JSEAD operation to the controllers at the ECC.

(2) The ECC controllers will manually turn off 2/3 of the ADA assets in the WPC game to mimic JSEAD operations in the given area.

8. ENGINEER:

a. Live Engineer obstacles will be imputed into the CBS simulation.

(1) Obstacles will be collected from umpire obstacle reports submitted to the UCC.

(2) Obstacles will be updated on the same schedule as live unit location updates.

b. Obstacle breach reports will also be imputed into CBS simulation on the same schedule as unit location updates.

c. Live units moving into a simulation zone will be effected by the simulated obstacles in that zone.

(1) The simulated engineer obstacle plan in the area will be transmitted to the unit's umpires through the UCC and ACC.

(2) Unit umpires will alert their units when they have encountered an obstacle and give them the type and extent of the obstacle. Units will be halted until the obstacle can be breached, using the Umpire Time Tables, or bypass can be found.

(3) Umpires will assess casualties against live unit vehicles and personnel that have come in contact with the obstacle.

(4) When a live unit breaches a simulated obstacle, the unit umpire must submit an obstacle breach report to update the simulation just as though the breach were made in a live obstacle.

(5) The ACC and UCC will pass the obstacle breach report to the simulation controllers at the ECC for input into the simulation data base.

d. In the event that the battlefield is taken over completely by WPC simulation, all engineer obstacles, both live and in CBS will be input into WPC simulation.

9. COMBAT SERVICE SUPPORT:

a. Combat Service Support module in CBS will be used to effect the CBS simulation. WPC and Live maneuver combat service support will be handled off-line.

b. The Logistics cell in the ECC will determine the Constrained Supply rates class III, IV, V, VII and IX for each day of the exercise. WPC, CBS, and live maneuver units will abide by the same CSRs.

c. Bulk CSRs will be manually input into the simulations at the ECC.

d. Red and Blue forces in CBS and WPC will abide by the same CSRs.

DISCUSSION

This section will discuss the observed degree of success at providing a seamless battlefield in each preceding functional area. These observations are based upon conversations with Major Hill after the exercise.

C2

Command and control across the seams functioned as expected in this exercise, although the duplicate simultaneous GRWSIM games and the continuous transition weekend created significant confusion during the exercise. However, the lack of the ability of assets in each command to affect each other across the different training modes affected how units in each training mode could be employed. The following sections present the difficulties encountered in the assessment processes in each functional area.

Overall, the command and control process was hindered by strong seams in the other functional areas, thereby restricting the employment of forces in each training mode.

MANEUVER

Maneuver was planned to be seamed between live and simulated units in this exercise. Live and simulated ground units could engage other ground units in close combat only in their own training mode. Simulated units would not be sent to engage actual units or vice versa, except in selected special cases, such as the rear area airborne insertion. Additional umpires would be sent to assess this event. Since the inserted unit was severely attrited before landing, the concept of assessing combat between live and simulated units was not thoroughly tested.

Maneuver was originally planned to be seamless between the two simulations. However, when it was known that the software interface between the two models would not be completed in time, an alternative method of close combat assessment was designed. However, this alternative method did not work well, causing all GRWSIM units engaged with CBS units in close combat to be destroyed.

Overall, the maneuver and close combat functional area was seamed in this exercise, as anticipated.

INTELLIGENCE

Intelligence requests were relatively seamless for the first part of the exercise. Requests to live assets were made through proper channels, as were requests to higher authorities for intelligence support.

Intelligence assessment was seamed in this exercise, for reasons described in the text. The simulated threat to the deep battle cells were not continuous. Simulated reports in the live box were more accurate but less timely than actual reports from the live box. Intelligence information was too detailed since it was not filtered by a training support cell. It was known that actual units could not engage in close combat simulated units and vice versa, which presented a reduced threat to units in a different training mode.

Overall, the process of intelligence requests was seamless, but the assessment of intelligence was seamed.

FIRE SUPPORT

We will first discuss fire support from artillery assets, and then fire support from air assets.

Fire support was planned to be more seamed than it turned out to be in this exercise. For example, before the exercise, it was unclear how easy it would be to pass and assess artillery missions between the live and simulated units, and between the simulations as well. Due to the presence of TACFIRE equipment in the live and CBS boxes, artillery requests were passed rather smoothly. In addition, players in the GRWSIM model could pass and be passed fire missions by phone.

Assessment of artillery fire missions then occurred in each training mode. Fire missions in the live box were assessed by umpires. Fire missions in each simulation were assessed by the algorithms in each simulation. Except for Lance missile fire requests, all of these fire missions and assessments flowed automatically after the first couple of days.

Overall, artillery fire mission requests and assessment were surprisingly seamless in this exercise.

Army aviation mission requests were seamless, as planned. However, the assessment of Army aviation missions were seamed. Helicopters in CBS could only fly in CBS, and similar constraints applied to the GRWSIM model and the live box. Since the range and flight path of helicopters would have taken them more frequently across the seams, this did not occur in this exercise.

Overall, Army aviation mission requests were seamless as planned, but the assessment of Army aviation missions was seamed, as expected.

Requests for fixed-wing aircraft missions were supposed to be seamless, but this was not the result. Due to the restriction that live aircraft had to fly against live targets, the availability of live versus simulated aircraft drove the number of requests for either live or simulated air missions. In addition, the assessment of aircraft flying in the AWSIM game and the CBS game were supposed to be seamless, but this did not occur. Due to the difficulties of representing air defense assets in both simulations (see below), duplicate missions had to be simultaneously flown both in the CBS and the AWSIM models.

Overall, neither the tasking nor the assessment of fixed-wing air missions was seamless in this exercise.

AIR DEFENSE ARTILLERY

It was intended that the density of air defense assets be duplicated in the CBS and the GRWSIM box, as recommended in the Caravan Guard 89 report. Each box would overlap air defense assets into the live box for purposes of assessing attrition to flights from each model over the live box. Unfortunately, this duplication of assets was discarded and replaced by a more elaborate air defense plan in support of each corps' operations. Although this air

defense plan was more realistic, the effect on the assessment of air missions was that the seams of each training mode were painfully obvious. As a result, work-arounds were employed, such as flying aircraft simultaneously in both models.

Overall, the assessment of air defense artillery shifted from seamless to seamed shortly before the start of the exercise. However, the order flow to air defense units was apparently seamless.

ENGINEERS

Requests for engineer support were intended to be seamless, and the results demonstrate that this process worked relatively well. However, the assessment of engineer activities was seamed. Some methods for compensating for these seams worked pretty well. CFX/FTX umpires in and near the CBS box carried maps indicating the location of minefields in the CBS model. However, minefield information passed to and between the simulations did not work as well. Minefields can be laid by control moves, but there was not automated interface to handle engineer effects between the simulations.

Overall, requests for engineer support were seamless, whereas the assessment of engineer support was seamed.

CSS

By the start of the exercise, it was assumed that the CSS representation would be seamed, and the results agreed with that assumption. From the beginning, CSS personnel were aware of the differences between live assets and live requests for fuel, etc., and simulated requests and supplies. Unfortunately, there was still confusion regarding whether a given request was from a live unit with a real supply need and a simulated unit with a simulated supply need. What will be required is a single logistics system for all training modes.

Overall, CSS requests and assessment were seamed in this exercise.